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SURGERY OF THE PITUITARY LESION *

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OF PHILADELPHIA, PA.

FROM THE NEUROSURGICAL CLINIC OF THE HOSPITAL OF THE UNIVERSITY OF PENNSYLVANIA

THE surgery of pituitary lesions has grown during the past fifteen years from a problem of minor to one of major importance. The first operation upon the pituitary body in our neurosurgical clinic was performed in 1912, and today pituitary lesions represent 15 per cent of our register of intracranial tumors. The surgical problems here involved differ in many respects from those of tumors of the cerebral or cerebellar hemispheres. In the latter we may be dealing with tumors within or without the brain mass, tumors cortical or subcortical, tumors encapsulated or non-encapsulated, tumors often difficult of localization, many of them inoperable, tumors in most instances associated with a high degree of intracranial pressure, tumors often of large dimensions, tumors for the most part malignant.

Contrast these physical factors with the pituitary lesion. The diagnosis in most instances is apparent: the location constant, the lesion entirely extracerebral, the pathology in the majority of instances benign, the size rarely of dimensions larger than the English walnut, often without any increase in intracranial pressure. The surgery of pituitary lesions differs from that of the brain tumor generally in that the primary purpose in the former is to save vision and in the latter to save life. The intimate relation of the pituitary lesion to the optic chiasm and optic nerves is an ever constant factor and one peculiar to the pituitary as contrasted with the brain tumor.

Another distinguishing feature in these two fields of intracranial surgery is that there are for the pituitary lesion two avenues of approach, namely, the transphenoidal and the transfrontal. In this clinic we have wavered at different periods between one and the other, but for the past three years have abandoned the transphenoidal route. Although realizing with the latter a lower operative hazard, we were however forced to recognize its limitations since recurrences of symptoms were not infrequent. By the transphenoidal route at most one can evacuate the contents whether liquid or solid, but the capsule remains undisturbed. Were the capsule always collapsible, so that when the contents were removed, the capsule collapsed, pressure on the optic chiasm and nerves would be released and the object of the operation accomplished.

* Read before the joint meeting of the New York Surgical Society and the Philadelphia Academy of Surgery, February 8, 1928.

nomenon, but by observation have the impression that when the lesion is approached from an angle, as along the greater wing of the sphenoid, rather than from directly in front, when the blade of the retractor does not press upon the structures directly overlying the pituitary region, but to one side, this blood pressure break down has not occurred. Hence in this lateral approach the portion of the lesion on the side opposite that of our flap is not so accessible. However, when we are confronted with a lesion of large dimensions, especially in its lateral rather than its antero-posterior dimension, the propriety of dividing the operation into two stages becomes apparent. We therefore venture to suggest the propriety of a bilateral approach, as in following case.

Summary—A young woman in her teens having for six years paroxysmal headaches, vertigo, visual hallucinations, epigastric pains and later visual defects, has an exceptionally large pituitary adenoma. To deal adequately with the lesion the operation is divided into stages, with an interval of three months. At the first the right portion of the tumor is removed, at the second the left. Both operations are well tolerated and the patient recovers with normal fields.

Female, aet seventeen years, File No 11339, was referred to the Neurosurgical Clinic of the University Hospital, January 26, 1927, through Doctor Baer of the Wills Eye Hospital.

Previous Illnesses—As a child she had measles, chicken pox, diphtheria and whooping cough. Later typhoid fever and influenza (1918).

Family History—There is no record of any endocrine disturbance in the family. Father was killed in an accident, mother, three brothers and three sisters living and well, two sisters died from tuberculosis.

History of Present Illness—The patient was quite well until 1921, six years ago, when she began to have severe *headaches*, throbbing in character and referred to the supraorbital region. These headaches at first lasted a few hours or for a day and then passed off, often associated with *nausea* and *vomiting*. *Tinnitus aurium*, right, often appeared after the headache subsided and persisted for a while. Two months before the headaches began she had a curious attack in which she thought she saw pictures of people appearing and disappearing on the wall (*visual hallucinations*). She heard no voices. These hallucinations lasted for a day or two and then vanished. She never saw bright light or scintillating scotomata. During the succeeding year the headaches recurred from time to time and were worse on stooping.

January, 1926, her vision began to fail as the patient said a film seemed to be growing over the eye from the temporal side. She noticed especially at night, as she lay in bed, that each night she could see less and less in the temporal fields.

As time went on she complained of a sense of weakness in the knees and later of *cramps* especially in the epigastric region. These pains were not related to the ingestion of food, at one time she had an attack of *transitory blindness*. All the while her headaches were continued with varying severity, mostly throbbing and frontal. Vomiting was occasional. At times she complained of vertigo, objects appeared to be turning around from left to right. Meanwhile her vision was becoming more and more impaired until she had another attack of transitory blindness on this occasion in the left eye. *Menstrual History*—Periods began in sixteenth year, two periods each month, excessive and painful. Arrest of menses April, 1927.

Physical Examination—*Head* Nothing abnormal about ears, nose, mouth or features. *Neck* There is a palpable and symmetrically enlarged thyroid gland. *Thorax*

There is only one feature of this operation that at any time has given us concern. In a few instances at the conclusion of the operation there has been an unexpected and unexplained fall in blood pressure. Assume the operation to have been performed under local anesthesia, the lesion to have been readily exposed and removed, with the loss of but an insignificant quantity of blood, the systolic blood pressure drops to 60 or thereabouts. The appearance of the patient would not excite alarm, the pulse may be accelerated, but the surface temperature of the extremities is warm, the skin dry, respirations not embarrassed, the patient conscious and quiet. Appropriate remedies, pituitrin, adrenalin and ephedrin are given hypodermatically, but without more than momentary effect. Any and every attempt to raise the blood pressure fails and after 24 or 36 hours conditions grow from bad to worse and collapse follows. We have been at a loss to satisfactorily explain this phe-

the lesion be exposed
ventricles becomes an imperative necessity, under no other circumstances can anesthesia. When there is an associated hydrocephalus, evacuation of the had to ether, that intracranial pressure is greater under the effects of ether operation begun under local anesthesia for some reason resort had to be est doubt in our minds, as frequently demonstrated, when in the midst of an only when there is a minimum of intracranial pressure. There isn't the slightest by elevation of the overlying brain mass, and this can be accomplished. With the objective situated at the base of the brain, access is obtained

anesthesia seems more specifically indicated in the pituitary operation. Cranial explorations local anesthesia is preferred to ether inhalation, local must reckon with a potential source of infection. While in most of our intracranial explorations local anesthesia is preferred to ether inhalation, local for the lower incision, on the grounds that in opening the frontal sinus one are unusually large, we select a crease about the middle of the head as the line eyebrow. In acromegalic subjects, in whom invariably the frontal sinuses toward the temporal fossa, in most one incision passes along the line of the In this clinic we have employed two methods. In all cases the flap is reflected. The flap for the transfrontal exploration may be fashioned in several ways

ventricle, offers greater difficulties in exposure and removal location, extending some distance behind the chiasm and beneath the third pie- and the post-chiasmal. Obviously a pituitary lesion in the post-chiasmal two recognized relationships between the pituitary body and the chiasm, the and its position with relation to the chiasm. In the normal subject there are by the transfrontal approach depends upon two factors, the size of the lesion. The facility or the difficulty with which the pituitary lesion may be dealt the transphenoidal approach had been employed

table in transfrontal operations performed on patients in whom previously is not a conjectural hypothesis, but has been demonstrated at the operating upon the optic chiasm are not relieved, or if relieved, may soon recur. This to the overlying structure remains undisturbed and the effects of pressure But in many instances the capsule is so firm and unyielding that its relation

The breasts are large for her age and recently have grown considerably in size. The lungs and heart present no abnormal signs. Blood pressure 106-54. *Laticuties*. The hands and feet seem disproportionately large for her age and race (colored). *Neurological Examination*. The reflexes are normal, there is no motor or sensory dysfunction, there is, however, impairment of sense of smell (left) and a right horizontal nystagmus.

Pituitary Phenomena—X-ray Pituitary fossa 22 mm by 16 mm. Beginning atrophy of the dorsum sellae. *Basal metabolism* minus 20 per cent. *Pressure*. Frontal headache. Pressure of cerebrospinal fluid 19 mm Hg.

Endocrine—Enlarged hands and feet. Smooth shiny skin. Enlarged breasts. Accession of weight ten pounds. Amenorrhea. Enlarged thyroid gland.

Ophthalmic—Bitemporal hemianopsia. There is pallor of both discs, especially on the nasal sides and more so of the left disc, with a yellow wax appearance. Vision, O D 6/6 O S 6/12. There is a crossed diplopia and some divergence.

First Operation—July 1, 1927. Transfrontal craniotomy. The flap was reflected from the right side, the lower margin of the flap about the middle of the forehead, rather than in the eyebrow. There was considerable dural tension, but this was found to be largely due to a collection of fluid in the subarachnoid space so that when the dura was opened and the fluid escaped in considerable quantity the pressure subsided.

Our usual technique was followed, elevating the frontal lobe and following the direction of the greater wing of the sphenoid. The right optic nerve was soon reached, much farther out than in the average case. The lesion was exposed and found to be a cyst adenoma. About a half of a hypodermic syringe full of bloody fluid was evacuated. The cyst wall was then penetrated and found to be lined with a layer of glandular tissue. As much of the wall as presented on the superior surface and on the lateral surface was removed that is, on the right side. No attempt was made to deal with the lesion on the left side. Tampons saturated with adrenalin were applied to the cavity for a few moments before the final closure of the wound, at which time hemostasis was complete. Wound closure without drainage. During the operation the blood pressure and pulse rate remained practically unchanged. The pulse rate was lower at the close than at the beginning of the operation. *Immediate Result*. Operative recovery. *Discharge* from the hospital, July 11, 1927.

In this case it was decided to remove the tumor in two stages, confining our efforts at the first stage to the left side and reserving the removal of the right side to the second stage. Since her discharge the patient has been free of symptoms. Her menses returned in September for the first time since April. The patient observes that she drinks more water than prior to the operation, 14 to 16 glasses a day (polydipsia).

Readmission—The patient states her vision has improved and the fields show definite retraction of the temporal fields, more marked on the right than on the left (see Chart). The cerebrospinal pressure is now 10 mm Hg as compared with 19 mm Hg before the first operation.

Second Operation—October 3, 1927. Transfrontal craniotomy left. Local anesthesia. Closure under ether. The flap was reflected from the left frontal area precisely corresponding to that of the first operation on the right—that is, a high frontal flap with the incision about the middle of the forehead. The dura was moderately tense as before and there was considerable fluid in the subarachnoid space.

The frontal lobe was carefully elevated until the olfactory nerve was seen, and then the optic nerve and to the inner side of the optic nerve the bluish wall of the tumor. A needle was introduced but no fluid was withdrawn.

An incision was made with a capsular knife and as much of the wall as presented was removed with a pituitary punch, so that the left optic nerve and the corresponding half of the chiasm was entirely free of pressure.

There was practically no bleeding although a small muscle graft was placed in the raw bed of the adenoma as a guard against oozing, and the wound closed without drainage.

Comment—Particularly impressive today was the uniform pulse and blood pressure.

SURGERY OF THE PITUITARY LESION

which continued at 120 throughout the operation and the pulse usually between 80 and 90 *Immediate Result* *Operative Recovery* *Pathological Diagnosis* Pituitary adenoma (basophilic)

The patient's convalescence was uneventful and she was discharged from the hospital October 14th eleven days after the operation. Her vision at this time was O S 6/6 and O D 6/12. There was no obscuration of the temporal fields.

One naturally hesitates to propose a two-stage procedure when one stage will suffice but the suggestion is made chiefly as a measure of safety and would seem to be justified by our experience in pituitary surgery. But while the primary exposure of the lesion is accomplished without hazard or difficulty, the subsequent steps of the procedure, that is the removal of the lesion, might be said to be a ticklish performance. The steps incidental to the removal of an endothelioma may be tedious, but the tumor is usually readily accessible especially those sagittally situated, and little harm is affected by displacement of the cerebral mass surrounding the tumor. Even the exposure and removal by suction of a degenerating glioma or the resection of a gliomatous cyst is attended with minor difficulties and little hazard.

But with pituitary lesions one must proceed gingerly. In the first place there is, as already mentioned, the harmful effect of retractor pressure. Then one must be especially careful not to make undue traction on the capsule. It would seem a simple thing after the capsule has been freed on its lateral and anterior aspects to dislodge and extract the capsule in toto by moderate traction. But such an attempt has been found to be a hazardous procedure. Here again one may see an alarming fall in blood pressure. One must be content patiently, with special punches and scissors, to resect the capsule piecemeal. Every step in this process must be executed with great delicacy, with a minimum of force. It is because, therefore, of these attending risks that additional precautions must be observed and only by so doing can one keep the operative mortality reasonably low. In our recent series of eleven transfrontal craniotomies there was one fatality. We have not yet reduced the mortality below 3.5 per cent in a series of thirty-five consecutive transphenoidal operations. But the inadequacy of the procedure, while free of risk, has a larger percentage of recurrences so that for the present at least we feel obliged to adopt the transfrontal method as the procedure of choice. And in tumors of large dimensions we employ the dual approach as recommended in this paper.

POST-OPERATIVE PULMONARY ATELECTASIS *

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AND

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OUR continued interest in the subject of post-operative pulmonary atelectasis has served to convince us more firmly in the probability of the statement made in our first report (ANNALS OF SURGERY, April, 1924, p 506), "that



FIG. 1.—C. M., male, white, fifteen years. Pennsylvania Hospital. Forty-two hours after radical right inguinal herniorrhaphy, massive atelectasis left lung.

the phenomena of pulmonary collapse of varying degrees, together with pulmonary embolism and infarction, are the real etiological factors in post-operative pulmonary complications." We agree with Mastics in his recent estimate that over 70 per cent of the so-called post-operative and post-anæsthetic pneumonias are varying degrees of atelectasis. We again state our belief that in the small proportion of true pneumonias developing post-operatively, all start as varying degrees of atelectasis, and upon these lesions are engrafted infarction and infection. *Massive atelectasis* involving more than one lobe of the lung, is usually mistaken for pleural effusion, empyema or pneu-

* A demonstration by motion pictures of the clinical phenomena of post-operative atelectasis and bronchoscopic removal of obstructing bronchial secretion, before the combined meeting of the Philadelphia and New York Academies of Surgery held February 8, 1928.

mothorax *Lobar atelectasis*, involving but one lobe, is diagnosed lobar pneumonia *Lobular atelectasis*, involving scattered areas in one or more lobes, receives the diagnosis of bronchopneumonia or pulmonary infarction. The fact that atelectasis has been recognized as a congenital lesion, occurring spontaneously, in bronchial and pulmonary infections, in nonpenetrating wounds of the thorax, abdomen and lower extremities, in increased abdominal pressure associated with tumors intestinal distention and peritoneal effusion, in postures immobilizing the thorax and abdomen, in nasal and pharyngeal diphtheria, in

foreign bodies in the trachea or bronchi, and following operations upon the abdominal wall, intra-abdominal organs genitalia and lower extremities indicates that more than one etiological factor may be involved. In the thirty-three cases of post-operative massive atelectasis whose records we have been able to study we are persuaded that two factors have been constant in this group first, a thick *viscid bronchial secretion*, and second, some *inhibition of coughing*. Because of the thick, tenacious character of this bronchial secretion and the inability, or disinclination,



FIG. 2—C. M., male, white, fifteen years. Pennsylvania Hospital. Röntgen ray taken fourteen hours after bronchoscopic drainage of the obstructing secretion from left main bronchus.

of the patient to clear it from the bronchi, it accumulates in the dependent portions of the bronchial tree until at some point or points this stream of mucous completely occludes the lumen. If this occlusion takes place in a small bronchiole, we will have *lobular atelectasis*, if it occurs in a bronchus leading to one lobe, we have *lobar atelectasis*, and if it occurs in a main bronchus of either lung, we will have *massive atelectasis*.

The mechanism by which such an obstruction may be produced has been recently suggested to us by the experimental work of Archibald, reported before the Association of Thoracic Surgeons at the New York meeting in 1927, upon *The Dangers of Cough* (*Arch. of Surg.*, vol. xvi, Part 2, No. 1, January, 1928, p. 322). The question was raised by Archibald that if the bronchial secretions are not entirely expelled by the expiratory effort, they might be

drawn further into the bronchial tree by the following inspiratory rush of air. He found that substances of a consistency of mineral oil were drawn further into and probably reached the terminal alveoli of the lungs after a number of coughing spells stimulated by mechanical irritation of the pharynx, while substances of greater consistency and viscosity such as mucus and sputum

were expelled by the first expiratory effort and cleared from the bronchial tree and were rarely drawn further into the bronchi. It is conceivable that when the viscosity of the bronchial secretion is not sufficient to insure its complete expulsion by the expiratory cough, nor sufficiently fluid to be drawn into the terminal bronchioles, it will move backward and forward at expiration and inspiration and definite waves will be created upon its surface. There is one point, of course, where the expiratory and the inspiratory wave meet and here a form of tidal bore may be created which can be compared to the wave produced by the meeting of tides in a narrow bay. This suggests to us an explanation of the piling up

FIG. 3.—Dog 456 Laboratory of Surgical Research University of Pennsylvania, Philadelphia. Rontgen ray taken by Doctor Pennington, twenty four hours before the exploratory laparotomy and experimental production of massive post operative pulmonary atelectasis of right lung.

of the stream of viscid bronchial secretion into waves, one or more of which finally reach the opposite wall of the bronchus and because of its viscosity, sticks and completely occludes the lumen of the tube. With recurring coughing and marked inspiratory efforts this mass of secretion is drawn further into the bronchus and complete obstruction is maintained.

Clinically we have demonstrated that if this obstruction can be overcome by making the patient cough by a change of position, as suggested by Santee by vigorous shaking, and in young children, by actual spanking, and an airway be established past this point or points of obstruction, the patient may, temporarily at least, free the bronchial tree of large masses of secretion and thus

reinflate the pulmonary tissues. In eight cases we have found it necessary deliberately to aspirate through a bronchoscope the obstructing portion of this bronchial secretion, and in each case immediate aeration and reinflation of the pulmonary tissue distal to the point of obstruction has followed.

The similarity of the atelectasis found by Chevalier Jackson in foreign body obstruction of the bronchi to that of post-operative massive atelectasis was discussed with Jackson by Leopold and Lee in 1923. Leopold suggested a condition of drowned lung to account for the density of the Rontgen-ray shadow found in post-operative massive atelectasis. Drowned lung was described by Johnson as an accumulation of a fluid exudate in the bronchi and air vesicles distal to the partially obstructing foreign body. The air enters and leaves until such a time as the vesicles become filled with exudate. In such a lesion there would be no actual decrease in the size of the lung, no true atelectasis, and, therefore, no displacement of the heart such as we find in the classic picture of massive atelectasis.



FIG 4—Dog 456. Laboratory of Surgical Research, University of Pennsylvania, Philadelphia. Rontgen ray taken by Doctor Pendergrass, twenty-four hours before the exploratory laparotomy and experimental production of massive pulmonary atelectasis of right lung—normal.

Recently at the Pennsylvania Hospital we have had presented an unusual opportunity in a case of massive post-operative pulmonary atelectasis of the left lung following a radical right inguinal herniorrhaphy under ether anesthesia. During the administration of the anæsthetic there was more mucus in the respiratory tract than usual, an observation which is very common in this group we have studied. About twenty-four hours after the operation breath-

ing became peculiarly distressing. It was quite evident that it was voluntarily restrained because of the pain in the operative wound. The temperature began to rise and there was a slight midsternal pain. Forty-two hours post-operatively, the respiratory distress was more marked, and the cough was short,



FIG. 5.—Dog 456 Laboratory of Surgical Research, University of Pennsylvania, Philadelphia. Röntgen ray by Doctor Pendergrass, three hours after exploratory laparotomy and the bronchoscopic introduction of 7 c.c. of the obstructing secretion removed by Doctor Clerf from the left main bronchus of the patient, C. M. (Fig. 1) with massive post-operative atelectasis.

shallow and but slightly productive of a tenacious sputum. At this time there was distinct displacement of the heart to the left of its normal position, and the clinical diagnosis of massive atelectasis of Doctor White was confirmed by Röntgen-ray examination by Doctor Bishop. Ten hours after the onset of these clinical symptoms and three hours after its confirmation by Doctor Bishop, Doctor Clerf drained through a bronchoscope from the left main bronchus 9 c.c. of the usual characteristic thick, tenacious bronchial secretion. Bacteriologic examination of this secretion gave a pure culture of pneumococcus. There was immediate relief following this bronchoscopic drainage, more complete and satisfactory than in any of the previous cases in which this had been attempted. The fact that in the other cases forty-eight hours was the shortest interval

between the onset of the symptoms and the bronchoscopic drainage was the explanation we gave for the more satisfactory results at this time. (See protocol No. 2 of Doctor Clerf.) This specimen of bronchial secretion was kept upon the ice for the next twenty-four hours until it was possible to provide the setting for its introduction into the main bronchus of a dog. In order

that all of the suspected etiological factors be provided, the dog was first narcotized with morphia, etherized, and then an operative incision was made through the upper half of the right rectus muscle, entering the abdominal cavity. This wound was closed by continuous layer sutures of silk and then strapped with broad adhesive plaster which encircled the lower portion of the costal arches, as we dress so many of our upper abdominal wounds. The dog was then laid upon his right side and after cannulizing the nasopharynx the bronchoscope was introduced into the main bronchus of the right lung and 7 cc of the secretion previously removed from the left main bronchus of the patient was introduced into the right main bronchus of the dog. At first there was definite coughing and struggling, which fortunately resulted in the drawing of the secretion into the deeper portions of the bronchial tree. At this point Doctor Ravdin introduced intraperitoneally 250 mgm of sodium amytal, with the object of producing a deep narcosis and eliminating the cough reflex. This was promptly followed by a deepening narcosis and the disappearance of the cough reflex. With the loss of the cough reflex, respiratory efforts became deeper and the entire mass of bronchial secretion was drawn into the right bronchus. A few minutes after the completion of the introduction of the bronchial secretion and following the removal of the bronchoscope, definite respiratory distress developed. This distress was so marked that it seemed for a time that the dog was about to die. The respiratory movements finally became regular and rhythmic and before the dog was placed in the kennel Doctor Ravdin said that the movements of the right side of the chest were almost lost, while those of the left side were very much exaggerated, and there was distinct bulging and a visible increase in the size



FIG 6—Dog No 456 Laboratory of Surgical Research, University of Pennsylvania, Philadelphia. Rontgen ray taken by Doctor Pendergrass three hours after exploratory laparotomy and the bronchoscopic introduction of 7 cc of the obstructing secretion removed by Doctor Clerf from the left main bronchus of the patient C M, (Fig 1) with massive post operative atelectasis.

of the left half of the thoracic cavity. The dog was kept on his right side for three hours, at the end of which time a Röntgen-ray examination made by Doctor Pendergrass at the University Hospital showed that there was complete atelectasis of all lobes of the right lung with transposition of the heart to the right beyond the spine. (See protocol No. 4 of Doctor Pendergrass.)

Although various substances have been tried to produce experimentally pulmonary atelectasis as far as we know this is the first successful attempt in which the obstructing bronchial secretion from a clinical case of post-operative massive atelectasis has been used to produce it in an animal. We feel that this opens a field of experimental research which will make it possible to evaluate the various etiological factors which have been suggested.

PROTOCOL No. 1—Abstract of history of Doctor St. Clair, Pennsylvania Hospital
Cosmo Mandli, male, white, single, fifteen years of age. Pennsylvania Hospital.

January 7, 1928—The patient was operated upon by Doctor Lee at about 2 P.M. today and a radical herniorrhaphy performed upon a right inguinal hernia. During the operation there was more mucus in the respiratory tract than usual and by the following afternoon twenty-four hours later, there was a definite cough, which, however, was restrained because of the resulting pain in his operative wound. There was a slight rise in temperature at this time.

January 8, 1928—The patient complained this evening about 11 P.M. of severe midsternal pain and some discomfort in his chest. He would put his hand over the left side of his precordia and point to it as the site of his discomfort.

January 9, 1928 at 8 A.M. approximately forty-two hours after the operation, his distress was more apparent and his cough short, embarrassed, frequent, and but slightly productive of a tenacious sputum. He complained of pain in his left axillary region which extended to his precordia with each attempt at coughing. The fever has risen slowly and steadily during the night and his sleep was definitely interfered with. One dose of elixir terpine hydrate with $\frac{1}{4}$ grain of codeine sulphate was his only medication. At the time of this examination, 8 A.M., there was distinct displacement of the heart to the left. This was between 2 and 3 cm. to the left of its normal position. There was hyperresonance in the left anterior chest which blended with gastric tympany. Posteriorly the findings are those of consolidation. There was some impairment, distant tubular breathing over the lower half of the left chest and posterior to the posterior axillary line. By noon of this day the apex was felt in the fourth interspace behind the fold of the left pectoralis major muscle. The whole anterior portion of the left chest was hyperresonant above this point and merged into the gastric tympany below. Posteriorly the whole left chest posterior to the posterior axillary line was impaired to percussion and there was distinct tubular breathing and egophony. The short, painful cough was increased and restlessness was very apparent at this time. There was a look of anxiety accompanying the restlessness. Cyanosis gradually appeared during the morning and by noon it was quite evident in the lips, ears and under the finger nails. At noon the contrast between the freely moving right chest and the comparatively fixed left chest was striking. At 2 P.M. the right border of the heart to percussion was to the left of the left border of the sternum (the compensating right lung was probably encroaching sufficiently to give a false right cardiac border). At this time Röntgen-ray examination was made. The fluoroscopic examination showed the typical picture of massive atelectasis of the left lung. The whole left chest was dark, in contrast to the right chest. The right diaphragm moved freely and with greater excursion than normal. It was impossible to recognize the dome of the left diaphragm because of the density of the shadows. Displacement of the heart was sufficient to place the right border beneath the sternum. On deep inspiration the heart displacement was increased toward

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the left side, so much so that the right border was distinctly to the left of the left border of the sternum. This was for a distance of a few millimetres. An X-ray picture taken at this time was interpreted by Doctor Bowen as follows:

"X-ray No 62537 Chest. Rather typical collapse of the left lung. There is, however, less displacement of the heart toward the left than we usually expect. There is practically no displacement of the trachea to the left. The lateral movement of the heart with respiration is sufficient to warrant the diagnosis. Presumably, the lack of displacement is due to a rather unusual amount of fluid in the collapsed lung."

PROTOCOL No 2—Doctor Clerf. January 9, 1928, 5 45 P.M., Pennsylvania.

A dose of morphia, gr $\frac{1}{4}$, and atropine, gr $\frac{1}{150}$, were given hypodermically and preparations made for bronchoscopy.

With the patient on the operating table a moving picture was started to show the patient's efforts to expel the obstructing bronchial secretion. This moving picture was continued during the bronchoscopic drainage.

Doctor Clerf's report of the bronchoscopic drainage is as follows:

"A large quantity of thick, tenacious mucoid secretion was coughed up through the bronchoscope as soon as it was introduced into the trachea, the left main bronchus seemed completely filled with secretion. In all 9 c.c. were aspirated and collected in a Lukens tube. The mucosa of the trachea, the orifice of the right main bronchus and the left bronchus with its subdivisions were inflamed. The lumen of the left bronchus seemed practically normal in size. Because of the continuous coughing efforts of the patient, it was difficult to make any observations regarding bronchial movements.

Bronchoscopic diagnosis. Acute tracheobronchitis. Plugging of left bronchus and subdivisions with thick, tenacious secretion. Secretion aspirated.

Remarks. The 9 c.c. of secretion collected does not represent the total quantity. Approximately three c.c. were coughed up through the bronchoscope and several additional c.c. were coughed up into the pharynx at the time of the laryngoscopy. The character of the secretion differs somewhat from that usually observed in these cases. It is grayish in color and contains many tiny air bubbles. As observed by Doctor Lee, this is probably due to the fact that bronchoscopy was performed very shortly after the onset of the collapse approximately ten hours."

Surgeons. Dr. Louis Clerf, Doctors Lunn and St. Claire.

In addition to the secretion which was obtained directly through the bronchoscope the moving picture shows very clearly the coughing up of several mouthfuls of this same viscid secretion after the bronchoscope was removed. In other words, after the bronchoscope had established an airway beyond the point or points of obstruction, the patient himself was able to clear the obstructed bronchial tree by his own voluntary efforts at coughing far more thoroughly than we were able to aspirate the material through the bronchoscope. The bronchoscope was of peculiar value in overcoming the obstruction and establishing the airway, but it was the patient's own efforts which were most productive in clearing the bronchial tree of its secretion.

PROTOCOL No 3—Dr. Gabriel Tucker. January 11, 1928, Dog No 456.

Bronchoscope was introduced by the Jackson technic, local anæsthesia used, 4 per cent cocaine to the larynx. The mucosa of the tracheobronchial tree was normal. There was no abnormal secretion. Secretion provided from the lung of a patient with massive collapse (Cosmo Manelli) (by Doctor Lee and Doctor Clerf) was introduced into the right main bronchus, and the larger bronchial subdivisions were filled with the secretion as high in the tracheobronchial tree as the carina. With inspiration no lumen appeared past the secretion, showing that it was completely obstructed. The preliminary morphine narcosis and ether anæsthesia was reenforced by the intraperitoneal injection of sodium amytal. This completely abolished the cough reflex. Before the bronchoscope was withdrawn the cough reflex could no longer be excited by intrabronchial manipulation. Careful inspection was made to insure that the secretion was placed only in the right lung.

LEE, TUCKER AND CLERF

Bronchoscopic Finding—Mucosa of the tracheobronchial tree normal Complete occlusion of the right main bronchus and its branches by bronchial secretion provided by Doctor Lee and Doctor Clerf from a patient with massive atelectasis

PROTOCOL No 4—Doctor Pendergrass January 12, 1928, Dog No 456

Control Films Heart is in the midline Both lungs aerated normally No increased densities were seen

Three hours after insufflation of material into the right bronchus There is almost a complete atelectasis of the entire right lung, especially the right upper lobe and to a less extent the right lower lobe The heart is displaced to the right

STUDIES ON EXPERIMENTAL PULMONARY ATELECTASIS

I THE PRODUCTION OF ATELECTASIS

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AND

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IN A paper published in the present number of this JOURNAL it is reported that atelectasis was reproduced in the dog after the injection into the main bronchus of some material, removed by Doctor Clerf, from a patient suffering from this condition. The present paper is one of a series of papers to come from this laboratory on the subject of atelectasis. Previous attempts to produce experimental atelectasis by foreign bodies have been successful (Mendelssohn in 1841 and Lichtheim in 1871). The more recent report of this type of atelectasis is that of Corryllos and Birnbaum, whose excellent review of the literature should be read by those interested in this subject.

The use of material removed from a clinical case has not been heretofore reported, nor has the condition been reproduced by the use of a synthetic material, similar in its viscosity to that removed from the patient. We believe that failure to reproduce this condition has been due to the inability to control the cough reflex and we further believe that with a material of proper viscosity, atelectasis can be produced at will without any alteration of the diaphragm other than that produced by the variation in the negative pressure of the pleural cavity which follows atelectasis.

In order that all of the suspected etiological factors be provided, however, the dogs were first narcotized with morphine, anesthetized with ether, and an operative incision was made through the upper half of the right rectus muscle, entering the abdominal cavity. This wound was closed by layer sutures and then strapped with broad adhesive plaster which encircled the lower portion of the costal arches, as we dress so many of our upper abdominal wounds. Sodium amytal (sodium iso-amyl ethyl barbiturate) was injected intraperitoneally, the amounts varying from 25 to 50 mgms per kilo. This resulted in profound anesthesia, with abolition of the cough reflex for from five to seven hours. The dog was then laid upon his right side and the bronchoscope was introduced into the main bronchus of the right lung and 6 to 7 cc of the secretion previously removed by Doctor Clerf from the patient, or of the synthetic substance, introduced into the right main bronchus.

With the loss of the cough reflex, respiratory efforts became deeper and the entire mass of bronchial secretion or acacia drawn into the right bronchus. A few minutes after the completion of the introduction of the bronchial

secretion or synthetic preparation and following the removal of the bronchoscope, definite respiratory distress develops. This distress is often so marked that it seems for a time that the dog is about to die. The respiratory move-

ments finally become regular and rhythmic although due to the anomaly they are slow. The movements of the right side of the chest become restricted, while those of the left side are very much exaggerated and there is a distinct bulging and a visible increase in the size of the left half of the thoracic cavity. The apex beat of the heart shifts to the affected side within thirty minutes to three hours.

The secretion removed from the clinical case was studied in this laboratory for its viscosity. It was found to equal in viscosity to a 100 per cent solution of acacia (tears). This study of the material from clinical cases is being further continued and will be the subject of a later paper.

The protocols of the experimental work follows. The X-ray photographs were made in the anterior-posterior position during inspiration and expiration and a lateral film was also made.



FIG. 1.—Dog 555. Laboratory of Surgical Research, University of Pennsylvania, Philadelphia. Röntgen ray taken by Doctor Pendergrass twenty-four hours before laparotomy and the experimental production of massive postoperative atelectasis of the right lung—normal. Lee, Ravdin, Tucker.

January 11, 1928.—Dog No. 1, No. 456, a small mongrel, weighing five and two-tenths kilos, which had been given 1/6 grain of morphine per kilo, was strapped to the usual wooden operating table with all four extremities extended and lying on his back. He was anesthetized with ether. The hair was shaved from the abdomen, the skin was scrubbed with soap and water and painted with tincture of iodine, and the iodine removed.

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with alcohol Under surgical asepsis a three-inch incision was made through the median edge of the right rectus muscle into the peritoneum This was then immediately closed with a continuous single suture of silk to close the peritoneum, a similar suture to unite the anterior sheath of the rectus muscle, and a continuous silk suture to approximate the skin and subcutaneous tissues The wound was then painted with iodine and the upper half of it was strapped with bands of adhesive plaster about two inches wide This band of adhesive plaster encircled the lower portion of the costal margin, with the object of immobilizing as we sometimes do in upper abdominal operations the lower portion of the thoracic area

At the completion of the operation Doctor Tucker, assisted by Doctor Jackson, anesthetized the pharynx and introduced a bronchoscope and through the bronchoscope 7 cc of the bronchial secretion which had been removed at 5 30 p m on January 9, from Cosmo Manelli a patient at the Pennsylvania Hospital This man developed massive collapse of both lobes of the left lung forty-eight hours after a right hemiorrhaphy performed by Doctor Lee This material had been removed by Doctor Cleif through a bronchoscope It had been kept in the original test tube in the ice chest and pneumococci were obtained from it in pure culture After the introduction of the bronchoscope we injected into the peritoneal cavity of the dog 260 mgms of sodium amytal with the object of producing a deep narcosis and eliminating the cough reflex Though the dog had been coughing

immediately after the introduction of the bronchoscope, the bronchial secretion was placed in the right main bronchus and the dog was kept lying on his right side In a very short time the cough reflex disappeared, and deep inspiratory movements drew the mucous deeply into the bronchi A few minutes after the completion of the introduction of the bronchial secretion he seemed to have definite respiratory distress This was at the end of or shortly following the removal of the bronchoscope This distress was so marked that it looked as though the dog was about to die The respiratory movements became deeper and before the dog was placed in the kennel, the movements of the right side of the chest were almost lost, while those of the left side were very much exaggerated and there was distinct bulging and a visible increase in the size of the left half of the thoracic cavity He was kept on his right side and three hours after the completion of the instillation of the bronchial secretion into the right main bronchus he was exam-



FIG 2 —Dog 555 Laboratory of Surgical Research, University of Pennsylvania, Philadelphia. Roentgen ray taken by Doctor Pen dergriss three hours after exploratory laparotomy and the bronchoscopic introduction of sputum into the main bronchus of right lung. Massive atelectasis right lung and transposition of heart to right of spine

med with the Rontgen-ray at the University Hospital. This radiogram shows complete collapse of all lobes of the right lung with a shifting of the heart completely to the right side beyond the spinal column. Unfortunately, this picture was not developed until the following morning, the dog was sent back to the kennels where six hours after the introduction of the first dose of sodium amytal he was given 130 mgms more. When he was found the next day he was lying upon his left side and the unilateral phenomena which was so marked on the preceding afternoon had now disappeared. A radiogram taken at this time showed that the heart had returned to its median position and that there were patchy areas scattered throughout both lungs, and we have a picture here of either diffuse lobular areas of collapse or a broncho-pneumonia.

January 12, 1928. After cocaineizing the pharynx, the dog was again bronchoscoped and found a much thinner and more purulent bronchial secretion in the bronchi leading to practically all of the lobes. This was aspirated.

January 19, 1928. Dog No. 2. No. 515. A grayish mongrel weighing four and one-half kilos, was given $1\frac{1}{2}$ grams of morphine at 2:30 and at 3:30 ether anesthesia was begun. After the abdominal wall had been shaved and the skin prepared with iodine and alcohol, under surgical asepsis a three and one-half inch incision was made through the median edge of the upper half of the right rectus muscle. This incision entered the abdominal cavity, after which the peritoneum was closed by a continuous suture of silk, the anterior sheath of the rectus was closed by a similar suture of silk, while the skin and subcutaneous tissues were approximated by continuous silk suture. At the completion of this operation we injected intraperitoneally 200 mgms of sodium amytal. Very shortly after this injection the dog's respiratory movements ceased. The heart continued beating normally and as this cessation of respiration had followed the dropping of the head over the end of the table preparatory to the introduction of the bronchoscope, the head was elevated and artificial respiration given by pressing upon the chest, and the bronchoscope was introduced without the slightest spasm or cough reflex. After some minutes the dog took a deep breath and then at the rate of about two inspirations a minute the respiration was finally reestablished. It was thought that this respiratory arrest was due to the narcotization of the morphine. The lower portion of the thoracic cage, including the costal arches, was then strapped with a two-inch band of adhesive plaster and through the bronchoscope, which was in the right main bronchus about 6 c.c. of the 100 per cent acacia was introduced, which was about the estimated viscosity of the material removed from the obstructed left bronchus of Cosmo Manelli, a patient at the Pennsylvania Hospital. This acacia was introduced very easily and at the conclusion of the introduction of the 6 c.c., the bronchus was apparently occluded. During the introduction of this substance the dog lay on his right side. After the removal of the bronchoscope it seemed that the left side was moving more freely than the right and, as a matter of fact, it was questionable whether the right side was moving at all. The bronchoscope was removed at 4:15 and the dog was immediately taken over to the X-ray room at the hospital and at 4:45, thirty minutes after the completion of the insufflation of the acacia mixture, a radiogram was taken, which showed the heart completely transposed to the right side of the spinal column. This was seen first at the fluoroscopic examination and later confirmed by the X-ray picture at 8:25 P.M.

Dog No. 555, a mongrel, female, weighing five and five-tenths kilos. An exploratory laparotomy was performed on this dog under the usual technique. It was placed on the usual operating table, its extremities extended, the dog was first given $1\frac{1}{2}$ grams of morphine hypodermically. It was then etherized and the skin of the lower chest and abdomen was shaved, scrubbed with soap and water and painted with tincture of iodine. An incision three inches in length was made through the right upper rectus muscle under usual surgical asepsis and the peritoneum was opened. The abdominal cavity was immediately closed by continuous silk suture to the peritoneum. A similar suture was used to unite the anterior sheath of the rectus muscle and the skin and subcutaneous tissues were approximated by a continuous silk suture. The wound was painted with tincture of

iodine and then immobilized by a two inch band of adhesive plaster which served to fix the lower thoracic cage. At the completion of this operation 175 mgms of sodium amytal was given intraperitoneally, which was at 10 30 P M. Doctor Tucker then introduced the bronchoscope without any difficulty, the cough reflex having been entirely inhibited by the sodium amytal. About 7 c.c. of an acacia substance with a viscosity of 128 was then introduced through the bronchoscope into the right main bronchus until there was no evidence whatever of an airway persisting. The dog was then laid on his right side and taken as quickly as possible to the X-ray room. Just thirty minutes after the introduction of the acacia substance the X-ray picture taken by Doctor Pendergrass showed complete atelectasis of all lobes of the right lung with transposition of the heart to the right of the spinal column.

DOCTOR TUCKER—Preliminary to bronchoscopy the dog received morphine and ether anaesthesia while laparotomy was being done. Narcosis was continued with sodium amytal. The reflexes were entirely abolished on introduction of the bronchoscope. The mucosa of the tracheobronchial tree is normal. A mixture prepared by Doctor Ravdin of acacia was introduced into the right main bronchus.

It was noted that a branch bronchus came from the right lung proximal to the carina. No attempt was made to introduce the mixture into this branch bronchus. The obstructing medium was introduced into the lower three lobes of the right lung. No effort at expulsion was made by coughing.

Twenty-four hours after the introduction of this substance the bronchoscopic examination of the tracheobronchial tree shows small quantities of secretion in the right bronchus with slight inflammatory reaction of the mucosa. The activity of this portion of the lung seemed to be less than on the left side. It was only possible to aspirate a very small quantity of the secretion. Reflexes were still present.

Dog No. 571, weight seven and five-tenths kilos. He received a preliminary dose of morphia, was deeply anaesthetized and then the skin was shaved over the lower thorax and the entire anterior abdominal wall. This skin was then scrubbed with soap and water and painted with tincture of iodine. An exploratory laparotomy was performed through an incision three inches in length passing through the upper half of the right rectus muscle. This wound was immediately closed by continuous silk suture, one to the peritoneum, a second layer to unite the anterior sheath of the rectus muscle, and a third to approximate the skin and subcutaneous tissues. The wound was then painted with tincture of iodine and strapped with a two inch band of adhesive plaster to immobilize the upper abdomen and lower thoracic cage. At the completion of the operation Doctor Tucker reported as follows:

The mucosa of the tracheobronchial tree, and the bronchial movements, were normal.

There was slight reflex spasm on introduction of the bronchoscope to the bronchus. At this stage Doctor Ravdin gave the dog intraperitoneally 200 mgms of sodium amytal and in a very short time the cough reflex was entirely lost in the deeper portions of the tracheobronchial tree. The acacia mixture was introduced through the bronchoscope into the right main bronchus. All branch bronchi below the level of the carina were filled with this mixture. It was noted that a branch bronchus came off proximally to the carina of the right lung. No effort was made to introduce the mixture into this branch bronchus.

Two hours later, on bronchoscopy, the mucosa was normal in appearance. There was no return of the reflexes. Considerable secretion was aspirated from all of the branch bronchi below the carina in the right lung. The substance had changed a great deal, being much more fluid in consistency than when introduced. The branch bronchi remained open after aspiration. It was thought by clinical examination that the lung had not reexpanded. A very slight amount of positive pressure was used. Following this it seemed apparent that there was a definite change in the position of the heart, it moving to the left side. This observation was not entirely confirmed by fluoroscopic examination. An

X-ray picture was taken by Doctor Pendergrass very shortly after this bronchoscopic drainage, and he reported as follows

Control films before the injection of the material show the heart to be deviated to the right slightly in inspiration, or possibly the dog was rotated slightly. The latter is more probable.

February 15, 1928, about two hours after injection of material, the examination showed atelectasis of the lower lobe on the right side and that the heart was markedly deviated to the right in both phases of respiration.

February 15, 1928. Examination of the dog shortly after removal by bronchoscopic drainage of the acacia substance which had been introduced into the right lower bronchus showed the heart to be in its normal position in both phases of respiration.

Dog No. 612, a mongrel, weighing three and five-tenths kilos. After receiving a preliminary dose of morphia and deep ether anesthesia the skin was shaved over the lower thorax and the entire anterior abdominal wall. It was then scrubbed with soap and water and painted with tincture of iodine and an exploratory laparotomy was done through the upper right rectus muscle. The abdominal wall was closed by layer sutures of silk, a continuous suture for the peritoneum, a similar suture for the anterior sheath of the rectus muscle, and the skin and subcutaneous tissues were united by continuous silk suture. The wound was painted with iodine and then strapped with a two inch band of adhesive plaster which immobilized the lower thoracic cage. One hundred and twenty-five mgms of sodium amylal was then given intraperitoneally and the bronchoscope was introduced by Doctor Tucker, whose report is as follows:

The bronchoscopic examination showed no spasm of the larynx. Reflexes were entirely abolished. The mucosa of the tracheobronchial tree and the bronchial movements were normal. A mixture of acacia prepared by Doctor Ravdin with a viscosity similar to that of the original material from the human was introduced into the main bronchus of the right lung, completely blocking the branches below the level of the carina. It was noted that a branch bronchus came off from the right side of the trachea to the right lung just above the level of the carina. The substance was not introduced into this branch bronchus.

Bronchoscopy two hours later and after it has been demonstrated by the X-ray that massive collapse had occurred in the right lung and that the heart had been transposed to the right of the spine, showed the mucosa of the tracheobronchial tree to be normal. There was some secretion in all bronchial branches below the level of the carina. It is much thinner in consistency than the substance introduced bronchoscopically. The material was aspirated and the branch bronchi remained open.

The same experiment of inflation with positive pressure was carried out and it was thought to distend the lung and allow the heart to return to its normal position. This observation was based on clinical examination and not on fluoroscopic examination.

X-ray report by Doctor Pendergrass was as follows:

The control films made before my experimental work was done showed the heart to be in the normal position and not displaced in the two phases of respiration. February 15, 1928, about two hours after the injection of the acacia substance the heart was found displaced to the right in both phases of respiration, but more on inspiration. The lateral view showed definite atelectasis of the lung.

February 15, 1928. A very short time after the bronchoscopic removal of the acacia substance by Doctor Tucker the heart was found to have returned to its normal position in both phases of respiration. A slight amount of atelectasis or lung reaction is present in both lungs.

THE DUODENAL TUBE AS AN AID IN THE SURGICAL TREATMENT OF EXOPHTHALMIC GOITRE

PRELIMINARY REPORT OF THIRTY CASES

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OF MADISON, WISCONSIN

FROM THE JACKSON CLINIC

SINCE the introduction of the use of iodine in 1922, in the pre-operative and post-operative treatment of exophthalmic goitre at the Jackson Clinic, no deaths have resulted from hyperthyroidism. Many patients have been admitted in crisis, frequently they were delirious and sometimes even moribund. Yet by the administration of iodine, of fluids, and by careful nursing recovery was made possible in every case. In some instances iodine could be administered only through the rectal or duodenal tube. In no instance was it necessary to resort to intravenous medication.

In 1923, in a series of cases of exophthalmic goitre in the Clinic, it was shown that such marked benefit resulted from the use of iodine that it was possible to perform primary thyroidectomy in 75 per cent of the cases. This report was refused by a leading medical journal because the procedure was looked on as too radical a departure. When Plummer pointed out that iodine was beneficial and was not harmful in exophthalmic goitre it seemed at first that most of the medical profession were slow to be convinced. This may have been the natural sequence of former disappointments. It is a question whether more imagination and less skepticism might have paved the way for more such discoveries. Iodine might have come into common usage in the treatment of exophthalmic goitre when Basedow first called attention to the benefit derived, or again when Trousseau pointed this out in 1864, or even in 1912 when Marine emphasized this fact.

While the statement made in 1923, that under the proper conditions it was possible to eliminate the ligation and stage operations in all but 25 per cent of the cases was considered too radical, it is now known that it was too conservative. Since 1924, only one ligation has been performed at the Jackson Clinic, and in this single instance it was entirely needless. During this time more than 200 primary thyroidectomies for exophthalmic goitre have been performed. Death did not result from post-operative hyperthyroidism, but a number of severe reactions occurred until our present knowledge was gained.

When iodine was first used successfully in conjunction with surgery in the treatment of exophthalmic goitre, the drug was administered with caution and in small amounts. In 1924, I became convinced that better results could be obtained if large doses were given both pre-operatively and post-operatively.

It appeared that the degree of reaction occurring after operation could be largely controlled by the amount of iodin. This was also true of the operation itself. Not only was the clinical condition remarkably improved so that the patient required no general anæsthesia, but thyroidectomy was greatly simplified because the gland was less vascular and friable. Gross pathologic study confirmed this observation and in 1925, I demonstrated microscopically the transition from hyperplasia to colloid.¹ Since then, however, Marine has shown me slides that he prepared in 1912, with the same observation. Unfortunately the remarkable effect that he observed did not become generally known and not until eighteen years later did Plummer revolutionize the treatment of this disease. If these facts had only been conclusively proved by Trousseau, Kocher, or even Marine, thousands of needless ligations and stage operations could have been eliminated, and many deaths might have been prevented.

There are certain qualifications to be made regarding the statement that primary thyroidectomy may be performed in practically all cases of exophthalmic goitre. Even in the hands of the most skilled operator unfortunate results occur because of the failure to attend to certain details. In thyroid surgery it is the little things that make the big things. There must be infinite attention in the care of the patient from the time he is first seen until he is finally dismissed from observation. To begin with, the patient's confidence must be won and the surgeon's experience has taught him that among other things it is advantageous to allow contact with patients who have already been operated on. The patient cannot be successfully cared for by untrained nurses. They must be keen, alert and above all, experienced. The condition of a goitre patient can change for better or worse in a few hours, depending on the nurse. The mere method of administering iodin is a simple matter and yet failure to use the proper methods nearly cost the lives of two patients I was called to see. The proper assistance in the operating room, the type of anæsthesia, and the experience of the surgeon are all factors that influence the successful outcome of thyroidectomy.

If one can count on all these conditions as being favorable and if the patient has received the proper amount of preparation, I believe that in the majority of instances primary thyroidectomy may be performed. Certain reservations must of course be made as, for example, when hyperthyroidism has persisted over such a long period that the heart is badly decompensated. Only occasionally age might be a factor. Neither of these conditions, however, has given me concern. The greatest risks occur when patients have been given iodin for many months until they have developed tolerance to it. In these cases I have learned that by greatly increasing their usual dosage, that is, giving 120 drops or more a day, they may be put in fair condition for operation. In such instances one may expect considerable post-operative reaction.

Before iodin was used in the treatment of exophthalmic goitre, post-operative hyperthyroidism was evidenced by a greatly accelerated pulse rate, extreme restlessness, and nervousness verging on delirium, fever with rapidly mount-

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ing temperature and gastro-intestinal crisis. The reaction as it is now observed is greatly modified, but in the more toxic cases the pulse rate may rise to 160 or more for a day or two, repeated emesis may occur and the temperature at times reaches 103° F. All of these symptoms are largely controlled by iodine, provided this is retained.

Frequently however, the liquid given by proctoclysis is expelled and emesis occurs almost as soon as the iodine is swallowed. At times the iodine even if well diluted seems to irritate the larynx causing an excess of mucus. To control these symptoms the duodenal tube was tried as a means of introducing iodine. This method has now been used in thirty cases and it has proved greatly beneficial. (Tabulation.)

SUMMARY OF THIRTY CASES

Factors	Average
Age	38.6 years
Duration of disease	15 weeks
Loss of weight	33.5 pounds
Days of preparation	9
Basal metabolic rate on admission	plus 65 per cent
Basal metabolic rate after administration of iodine	plus 46 per cent
Basal metabolic rate on discharge	plus 11 per cent
Pulse rate on admission	132
Pulse rate after administration of iodine	94
Pulse rate after thyroidectomy (maximal)	122
Temperature after thyroidectomy (maximal)	102.3° F
Days in bed after operation	4.5

In order to perform primary thyroidectomy in all cases, various methods have constantly been studied to reduce post-operative reaction. Certain nurses were especially trained to care for these patients, so that they might be familiar with every detail. For the past two years, at the suggestion of Dr. Harold E. Marsh, each patient was given 30 gm. of glucose and 100 gm. of orange juice two hours before operation. Lugol's solution, four doses of 10 drops each, has been given preceding thyroidectomy. All patients received ¼ grain morphine and 1/300 grain scopolamine an hour before operation. This procedure together with local anaesthesia has been used for the past eight years at the Clinic and has proved entirely successful. Patients leave the operating table in practically the same general condition as before the operation. Only rarely it may be necessary to resort to nitrous oxide and then one is impressed with the fact that the patient is no longer under the control of the surgeon but rather of the anaesthetist. The increased venous congestion adds to the difficulties of the surgeon because of the increased hemorrhage.

Although the degree of post-operative reaction was considerably modified by these measures, there still remained a certain group of cases that caused some apprehension. These were the patients who were troubled with mucus or repeated emesis. It seemed that if the iodine could be introduced directly into the duodenum these difficulties could be overcome. The first case in

which the duodenal tube was used, was that of an extremely toxic patient who previous to treatment registered a basal metabolic rate of plus 86 per cent. Thyroidectomy was successful under local anesthesia, but during the afternoon it was impossible for the patient to retain iodine either by mouth or rectum. At five o'clock a duodenal tube was passed, iodine and fluids were introduced freely and within thirty minutes the patient's condition had improved so remarkably that satisfactory recovery was practically certain.

The next case in which the tube was used was that of another extremely toxic patient. He showed signs of developing pneumonia through the accumulation of excessive mucus that was apparently due to irritation of the larynx from iodine. The tube was passed and the tendency to formation of mucus greatly reduced by introducing iodine and fluids directly into the duodenum.

While the use of large doses of iodine, glucose, and orange juice preceding operation has modified post-operative reaction the most important factor in my experience, since the introduction of iodine has been the use of the duodenal tube before, during, and after operation. As a result of early experience, it was decided to introduce the tube the afternoon before operation. This allowed the patient to adjust himself to the tube and at the same time by use of the Murphy drip gave assurance that even while the patient was asleep, fluids, nourishment, and iodine were being absorbed. The patients now come to the operating room under ideal conditions. The period of time that formerly elapsed previous to operation in which the patient received no fluids or iodine is now eliminated. These ideal conditions are enhanced by the fact that any tendency to hyperthyroidism that might develop is held in check by the constant introduction of iodine, fluids, and nourishment through the tube while the patient is on the operating table. The duodenal tube is attached by a rubber tube to an ordinary proctoclysis can suspended on a stand. It causes little or no annoyance to the patient, some actually prefer to allow the tube to remain rather than to undergo the exertion of swallowing.

I have always felt that, no matter how serious the case if operation was to be performed at all primary thyroidectomy could be as safely done as ligation or the stage operation, provided it could be performed under ideal conditions. The use of the duodenal tube has supplied the one needed factor, that of insuring a constant intake of iodine, fluids, and nourishment, without increasing the amount of mucus.

Since using the tube the post-operative reaction occurring in cases I have observed has been negligible. These include elderly patients, long standing cases, children, and serious cases in which the patient has been on iodine treatment for a long time.

As a rule the tube is withdrawn in forty-eight hours, occasionally it is removed sooner, or is allowed to remain another day. Patients often experience a mild crisis on the day after operation, if however their condition is good at this time and the intake of fluids has been satisfactory the tube may be removed. In two cases the tube appeared to hinder the patient from expect-

torating mucus and as it seemed to have served its purpose it was removed

I have not felt it necessary to use the tube in every case, but only when more than the usual degree of post-operative reaction is anticipated. While the degree of reaction that may be expected cannot be absolutely predicted, it is always possible to introduce the tube after operation.

Although the ligation operation has been safely discarded in the Clinic, I hesitate to emphasize such a statement. However, I feel that our patients are submitting to thyroidectomy under very favorable conditions. For those who perform an occasional operation without the advantages of an especially trained staff, it would perhaps be advisable to proceed with more caution. A ligation operation need no longer be looked on as a means of temporarily improving the patient's condition, but rather as a test of his ability to withstand more extensive surgery. Nor should thyroidectomy itself be considered with impunity because the more radical operation as performed today is undertaken with greater risk than was recently the less extensive procedure.

To those who are daily engaged in thyroid surgery, the duodenal tube is suggested as a means of modifying post-operative reaction. To those who occasionally perform such operations the tube is suggested as a helpful measure for either the ligation stage or primary thyroidectomy.

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THE THERAPEUTIC VALUE OF IRRADIATION IN THE TREATMENT OF MAMMARY CANCER

A SURVEY OF FIVE-YEAR RESULTS IN 355 CASES TREATED AT THE
MEMORIAL HOSPITAL OF NEW YORK

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THIS paper represents an analysis of the results obtained by irradiation, with and without surgery, in 182 primary operable and 173 primary inoperable cases, admitted to the Breast Clinic, five years or more ago. Our effort has not been directed to prove irradiation effective, but to ascertain its value, if it had any. The patients have been followed continually, the percentage of the follow-up being 97.2 per cent.

We will first discuss the technic of irradiation.

TECHNIC OF IRRADIATION

The large literature which has accumulated upon irradiation methods and dosage, attests both the difficulties and the importance of the problem. A gradual improvement in technic has resulted, from the employment of better X-ray equipment, more satisfactory radium applicators and an accumulation of data from the physical and pathological laboratories. Most of the patients, in this report, received the major portion of their treatment before these more effective methods had been developed.

Treatment by X-rays—Until the year 1920, the only Rontgen-ray machines in use at the Memorial Hospital for therapeutic purposes, were those of the so-called low-voltage type. The treatment was given in cycles, each cycle including from four to six treatments. The whole breast and adjacent regions were divided into four or six areas, each area being treated on successive or alternate days, until all had been irradiated. This type of treatment was given, in some instances, for months, with little or no intermission between cycles. While subject to considerable variation, the set-up for delivering the dose was as follows: A peak voltage varying between 120–135 K.V., 5 milliamperes of current, 3 to 4 millimetres of aluminum filter, a focal distance of 8 to 8¾ inches, and a treatment time of 3 to 6 minutes. Later, the time was lengthened to 7 or 8 minutes, the focal skin distance increased to 9 or 10 inches, but the number of aluminum filters was unchanged. We have, arbitrarily, called this form of X-ray treatment, L. V. I.

A review of our earlier clinical records reveals a considerable latitude in planning and delivering X-ray dosage. Although our experience was meagre, the treatment of each patient was considered an individual problem, to be dealt with as the best clinical judgment would dictate. A large corpulent

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subject was treated with a large portal of entry, the focal skin distance being also increased, if the tumor lay at a considerable depth. Superficial foci in the skin and subcutaneous tissue responded more readily to this form of therapy, but some of the deeper lesions also showed a considerable degree of regression, when persistent and repeated treatments were continued over a long period of time.

It seemed probable that a more intensive type of treatment would yield more satisfactory results and accordingly, about 1921, the low-voltage technic was considerably modified. The set-up included a peak voltage of about 140 K V, 4 milliamperes of current, 4 millimetres of aluminum filter, a 10 to 12 inch target skin distance and a 15 minute exposure. The size of the skin areas exposed was not constant, but the average portal used was, approximately, 300 square centimetres. We designated this mode of treatment, L V 2. This method seemed more effective in



FIG. 1.—Carcinoma of the breast following irradiation. Section shows hyalinization and lymphocytic infiltration.

delivering a dose to a tumor at a depth. More satisfactory regressions and more pronounced histological changes were obtained, in shorter periods of time, than had been possible with the L V 1 type of therapy.

The desire to approximate the intensity of radiation obtained by the new high-voltage machines led to a further modification in low-voltage technic in 1922. With the same peak voltage of 140 K V, using 4 milliamperes of current, 5 millimetres of aluminum filter and an average portal of entry of 300 square centimetres, the focal skin distance was increased to 15 inches and the time to 25 minutes. This type of treatment has been designated, L V 3. The regressions in deeper tumors obtained by this newer technic seemed more often satisfactory than with either of the two former methods.

During the past five years, high-voltage therapy has been utilized as one of the methods of treatment in dealing with mammary cancer by irradiation. The regressions obtained by its use, in general, have been more pronounced

than by any of the previous low-voltage methods. The massive dose technic, begun in Germany, has had many adherents in this country, but at the Memorial Hospital, the so-called, divided dose method, has been considered safer therapy. The set-up with our treatment by high-voltage has been as follows. A peak voltage of 180 to 200 K V, 4 milliamperes of current, $\frac{1}{2}$ millimetre of copper and 1 millimetre of aluminum filter, with a portal of entry of about 300 square centimetres, a target skin distance of 50 centimetres was used. The time of exposure has varied from 60 to 80 minutes, the former delivering a suberythema dose, while the latter has usually produced a distinct erythema. This type of therapy has been designated H V.

Mrs Edith H Qumby, of the physical laboratory, has furnished the following table, indicating the effect of the size of the diaphragm on the quantity of radiation reaching a given point. The results in this table are based on experimental work. The values for the 10 x 10 centimetre diaphragm have been used as standard, and the change in both surface and depth doses for other diaphragms given. The work has not been done for the lower voltages, but there would be a similar variation in intensity of about the same magnitude.

TABLE I

Effect of Size of Diaphragm on Quantity of Radiation Reaching a Given Point

200 K V

50 cm F S Distance

0.5 mm Cu & 1 mm Al

Depth cm	Diaphragm Area Sq cm					
	600	100	200	100	50	25
0	116	114	104	100	93	86
2	109	108	99	94	85	74
5	85	82	72	66	56	44
10	48	46	37	33	26	21
15	30	27	22	17	13	10

The larger the portal of entry, the larger is the dose delivered to tissue at any depth, because of the added amount of scattered radiation. For example, let us compare the quantities of radiation obtained with a portal of 25 square centimetres to those with a portal of 100 square centimetres. At the skin surface, the smaller portal provides 86 per cent of that obtained with the larger diaphragm. At a depth of 5 centimetres, but 66 per cent is delivered, while at a depth of 15 centimetres the figure falls to 17 per cent.

It is apparent that the portal of entry is an important factor in dosage, and it must be recorded for a proper estimation of the dose delivered.

Mrs Qumby has, also, furnished the following table showing depth doses for various types of irradiation. The data for L V 2, high-voltage, and the 6 and 10 centimetre packs are experimental. Those for L V 1, L V 3 and the tray are calculated.

If one compares the percentages of skin erythema dose delivered by

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L V 1 and H V at a depth of 7 centimetres, but $\frac{1}{3}$ of the skin dose is delivered by the former, while $\frac{1}{2}$ is delivered by the latter. With a depth of 10 centimetres the percentages are 18 per cent and 33 per cent. Leaving out of consideration the quality of radiation which these types of X-rays deliver it is apparent that the higher voltages should be more effective in dealing with tumour tissue at a depth.

TABLE II
Depth Doses for Various Types of Radiation

Depth cm	L V 1	L V 2	L V 3	High Voltage	Radium Pack 6 cm	Radium Pack 10 cm	Radium Tray 3 cm
0	100	100	100	100	100	100	100
2	72	76	78	94	55	61	36
4	53	55	58	75	36	46	17
7	33	36	39	51	21	31	7
10	18	20	22	33	14	21	
15	7	8	9	17	8	12	
20				8	5	8	

It is important to note that almost all of the cases in this report have been treated by low-voltage methods, and a majority of them have received only the L V 1 type of radiation.

Radium Therapy—Clinical experience seems to indicate that the gamma rays of radium, with their shorter wave lengths, probably produce a different therapeutic effect upon tumour tissue than do X-rays. Aside from its use as an external agent, radium is available for interstitial irradiation, permitting more varied types of therapy. Radium has been employed externally in the form of a pack or tray, and interstitially, in the form of glass emanation tubes or platinum needles.

Pack—In the earlier years of treatment the pack was constructed, having an area of 70 square centimetres and a filtration of $\frac{1}{2}$ millimetre of silver and 2 millimetres of lead. Placed at a distance of 6 centimetres, the average dosage employed was 12 000 millicurie hours. The radium pack carried an amount of emanation varying from 1200 to 2500 millicuries, the emanation tubes being distributed as uniformly as possible in the container. The present pack differs from the one just described in the total filtration, which is now $\frac{1}{2}$ millimetre of silver and 1 millimetre of brass, being equivalent to 2 millimetres of brass. In treating breast lesions and axillary and supraclavicular disease, the distance has been 6 centimetres from the skin.

With the new pack, at first, a dosage of 8000 millicurie hours was employed, which, on account of the lower filtration, was the approximate equivalent of 12,000 millicurie hours, when the older type of pack was used. Later the dosage was raised to 9000 millicurie hours, then 10,000, and more recently to 12,000 millicurie hours. In the average patient, the latter dose produces a well-marked erythema and occasionally blistering. Our best results with the 6 centimetre pack have been obtained by cross-firing on either side.

of a breast tumor with a full erythema dose, or by repeated treatments of supraclavicular nodes and large recurrences or metastases of the chest wall. Many satisfactory regressions in metastases to bone, especially in the spine, have occurred in using the 6 centimetre pack, when the distance has been increased to 10 centimetres and a dosage of 18 000 to 20,000 millicurie hours



FIG. 2.—Radiation effects in mammary cancer: fragmentation and hyperchromatism of nuclei, hydropic degeneration of cells and necrosis.

used still better results have been obtained. Our most striking regressions have occurred when both high-voltage X-rays and the radium pack have been employed over identical areas, an interval of only two or three days intervening between treatments.

Tray—The radium tray is a small applicator 4 x 6 cm. in size, designed for the treatment of smaller lesions, the filtration being the same as for the pack. The amount of radium available is usually 1000 millicuries, and with a dosage of 3000 millicurie hours at 3 centimetres distance, a fairly full erythema appears. Our best results in the use of the tray have been obtained in the treatment

of recurrences of the chest wall, small primary tumors of the breast, or metastases in the lower part of the axilla. Combined with high-voltage, it has been still more effective.

Interstitial Irradiation—This form of irradiation has been given, employing glass emanation tubes or platinum needles.

Glass Emanation Tubes—These emanation tubes have often been termed, "bare tubes," as no filter, save the glass, was provided. The implantation of these tubes into tumor tissue has been accomplished by means of needle trocars, with a minute metal plunger. One tube with a value of 1 to 1.5 millicuries was introduced into each c.c. of tumor tissue to be treated. In treating a small neoplasm, an even distribution of bare tubes was possible. A disadvantage arose in connection with the use of bare tubes, from the inflammatory

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reaction induced by the beta rays, which the glass does not filter out. Frequently, this inflammation was marked, the patient suffering considerable discomfort and pain. Nevertheless, some of our best results in the primary operable cases treated by radiation have been obtained by the use of bare tubes, in small localized carcinomas of the breast.

Platinum Needles—When larger tumors were to be irradiated, platinum needles, with a filtration of 0.4 millimetre of platinum have been employed, as it was impossible to implant bare tubes uniformly throughout the mass. The needles were spaced about 2 centimetres apart. The immediate regressions were striking, in some of the early cases treated with these needles. With a dose as small as 70 millicurie hours per needle, some tumors regressed and have remained quiescent over a period of years. We now know that these dosages were wholly ineffectual to completely destroy the lesion. The dose has been increased to 700 millicurie hours per needle for the primary tumor, and 500 to 600 millicurie hours for the treatment of metas-



FIG. 3—Necrosis of cells in mammary cancer following irradiation

tases to axillary nodes. The needles should never be introduced nearer the brachial plexus than 2 to 3 centimetres, for otherwise an intractable and distressing neuritis may result. Such a complication has arisen in but two of the patients in this series.

Limitations of Radium and Rontgen-ray Therapy—Light-complexioned individuals, and especially those with reddish hair and ruddy complexions, develop a skin erythema more readily than do brunettes. In treating the former, a dosage less than the average should be planned and given, or skin damage may follow. Upon the other hand, anemic and under-nourished individuals develop an erythema less readily than does the average patient.

The general condition of the patient must be borne in mind, in planning any form of radiation treatment. An individual in poor general condition

should not be subjected to prolonged or heavy irradiation, for such a patient does not react well to the use of these agents, and the local lesion regresses less satisfactorily. In this group, the best result that may be hoped for, is a certain degree of palliation.

The adjacent normal tissues irradiated have a limit of tolerance. The skin will stand only a certain amount at any single dose, and repetitions of

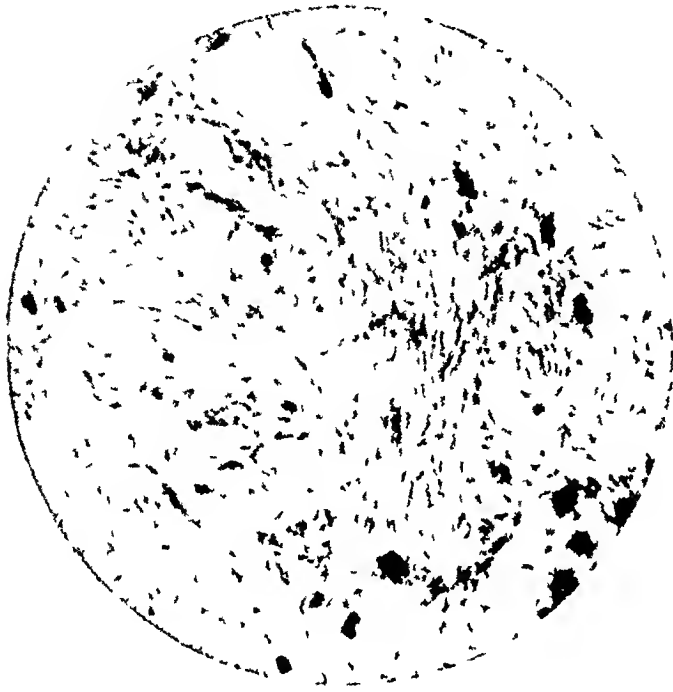


FIG. 4—Hyalinization in mammary cancer produced by radiation

treatment may not be carried on indefinitely or skin destruction will surely follow. This untoward accident occurred in a few of the earlier cases treated, but no such complication has arisen in recent years.

The subcutaneous tissue atrophies with prolonged irradiation, associated with a gradually diminishing blood supply, and treatment here, also has definite limitations. In dealing with chest metastasis, the lung tissue is likewise irradiated and numerous cases have been reported in the literature

of diffuse and sometimes fatal pulmonary fibrosis, following a prolonged series of heavy high-voltage treatments of the chest. No case of extensive or fatal pulmonary fibrosis had ever occurred at the Memorial Hospital as far as our knowledge goes.

In treating metastasis to supraclavicular nodes by external radiation, persistent treatment may result in an intractable neuritis of the brachial plexus. One patient, in the present series, suffered from this complication, following the use of four radium packs and four high-voltage treatments over one supraclavicular area.

Late Skin Changes Following Radiation—When the L. V. 1 type of treatment has been used over a long period, considerable skin atrophy and small telangiectases may appear, two or three years later. In many cases these have increased in size and number, often covering the entire irradiated area. Observed year by year, a few of these patients have exhibited skin changes, which were progressive, and ultimately, areas of ulceration made their appearance. In two instances, a squamous-cell epithelioma developed in the over-irradiated skin. In one case a wide surgical removal of the diseased area, done six years ago, has been successful in eradicating the disease.

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The second patient has, up to the present writing, refused operative interference

Gross and Microscopic Changes in Tumor Tissue Induced by Radiation —

Gross Changes When adequate external radiation is used or the interstitial method employed or when the two methods are combined, changes occur in the tumors treated with varying degrees of response, for tumors differ with

respect to their radio-sensitivity, the more cellular being uniformly the more radio-sensitive. Marked regression in size was observed in some of the more cellular neoplasms, within two to four weeks from the time of treatment. Complete disappearance of the mass followed in a few instances. We now consider that a marked diminution in the size of a breast tumor or its complete disappearance, following irradiation, is trustworthy evidence of cancer. Therefore, this reaction is

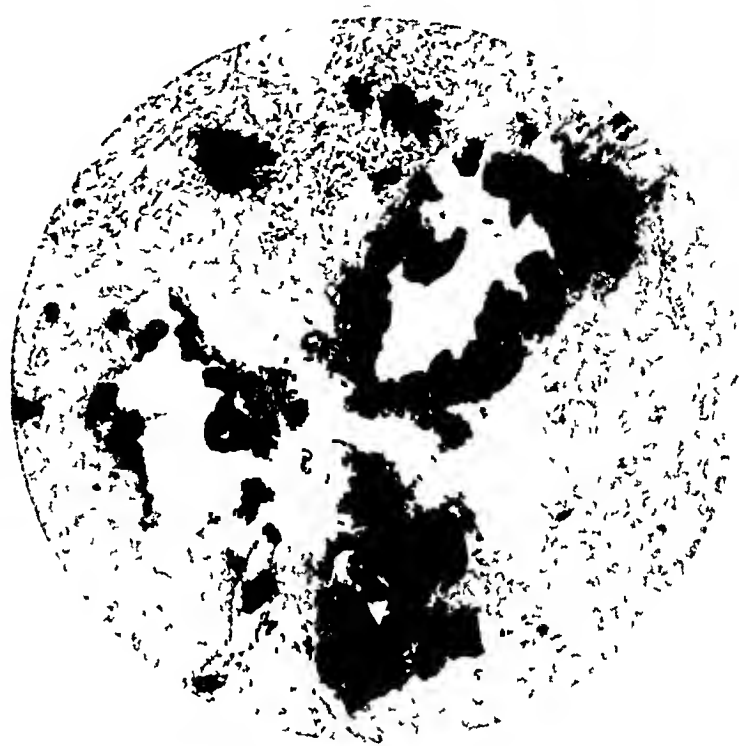


FIG. 5.—Late radiation effect in mammary cancer. Extreme degree of calcification

of diagnostic value, no other tumor of the mammary gland responding to radiation in this characteristic way. Exceptionally, a cancer of the breast may show little or no regression following irradiation.

When mammary carcinoma, which has been adequately irradiated, is sectioned, certain gross changes are evident, consisting of small areas of necrosis or liquefaction, representing devitalized masses of tumor cells and stroma. Necrosis throughout the entire tumor is unusual. These areas are more frequently encountered when interstitial radiation has been employed, and may extend 1 to 2 centimetres on all sides of the site of radium implantation.

Microscopic Changes—The material available in the pathological laboratory has permitted the study of a considerable number of cases, showing radiation effects. The histological evidence of changes in cancerous tissue, induced by radiation, may be summarized as follows: Hyalinization of connective tissue, granular degeneration of the stroma, obliterating endarteritis, granular or hydropic degeneration of the cell cytoplasm, hyperchromatism, fragmentation or degeneration of nuclei, lymphocytic and plasma cell infiltration, considerable areas of necrosis, and occasionally in tumors, following prolonged irradiation, calcification. The limits of the present paper will not permit a further discussion of these changes.

PRIMARY OPERABLE PATIENTS

Patients were placed in this series, based upon criteria, which the writer has outlined in previous papers. The cases have been studied in the three following groups

Group A	Received pre-operative irradiation, radical surgery and post-operative irradiation	41
Group B	Received radical surgery and post-operative irradiation	76
Group C	Treated by irradiation with or without palliative surgery	45
Total		162

Twenty patients were excluded from these groups for reasons indicated in Table III

TABLE III
Results in Primary Operable Patients

Group	No	Alive Well	Alive Recur rent	Dead	Dead of Intercurrent Disease	Lost Track	% 5 yr Results
A Pre-operative Irradiation, Surgery, Post-operative Irradiation	41	14	1	24	2 [after 5 yrs]	0	39
B Surgery Post-operative Irradiation	76	26	0	49	0	1	35
C Irradiation	45	11	1	22	6 [2 after 5 yrs]	5	36
Pre-operative Irradiation, Surgery	7	4	0	3	0	0	57
Surgery Irradiation for Recurrence	5	2	0	3	0	0	40
Surgery Alone	1	1					100
Irradiation 3 yrs later Surgery	1	1					100
Local Excision Irradiation	6	2		3	1 [after 5 yrs]		50

Patients dying from intercurrent disease, after the five-year period, but with no evidence of cancer, have been considered five year satisfactory results. Patients dying from intercurrent disease, before the expiration of the five years, but without evidence of cancer, have been excluded from statistical study, as well as those who have been completely lost track of.

This series offers an opportunity for a comparative study of results in the treatment of mammary carcinoma by radical surgery, combined with irradiation, as compared with those obtained by the use of physical agents alone. Moreover, it permits an evaluation of the efficacy of the types of pre-operative and post-operative irradiation, which we have employed. It also affords a comparison of results achieved by radical surgery, plus irradiation with

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those obtained by radical surgery alone, the latter group having been presented by the writer and an associate to this Association in 1924

These groups may also be compared from the standpoint of total duration of disease and duration after treatment

TABLE IV
Duration of Disease
(Primary Operable Patients)

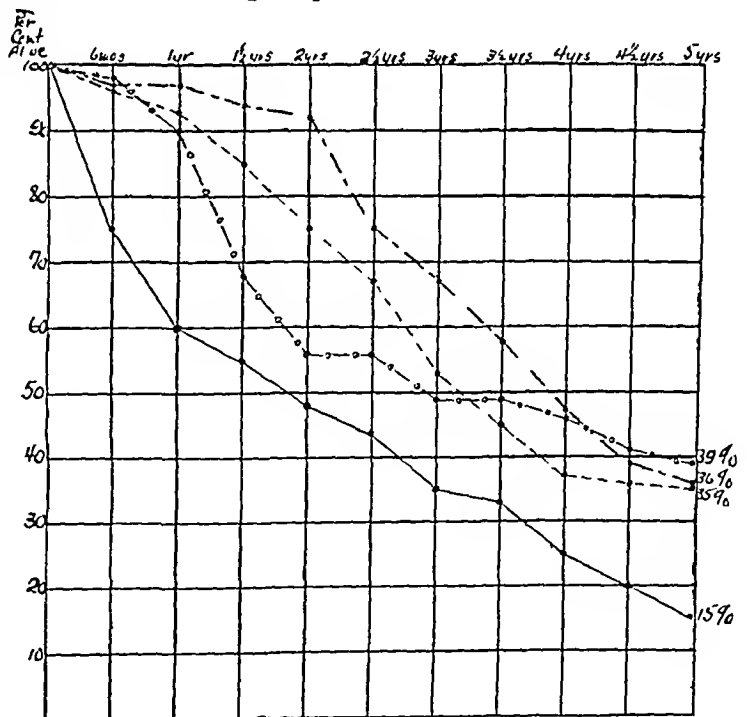
Group	Total Duration		Duration after treatment	
Surgery Alone	4 yrs	1 mo	3 yrs	70 pts
Pre-operative Irradiation Surgery Post-operative Irradiation	5 yrs	2 mos	3 yrs 9 mos	41 pts
Surgery Post-operative Irradiation	5 yrs	1 mo	4 yrs 3 mos	75 pts
Radiation Alone or with Palliative Surgery	5 yrs	10 mos	4 yrs 6 mos	45 pts

The following graph illustrates the percentage, alive and well, without recurrence at six months' intervals in each group

A study of Table III and the graph indicates no apparent advantage in favor of surgery, combined with radiation, over treatment by irradiation alone. From a statistical standpoint the figures are identical, for the difference in percentages is too slight to be significant. Either much larger groups must be studied, or these three groups followed for a longer period of years, for then a considerable divergence in percentages would be of real significance.

One striking conclusion to be drawn from the graph is, that mammary

cancer treated by surgery alone, gives a lower percentage of satisfactory five year results than any of the radiation groups. However, the writer desires



GRAPH 1—Graph showing per cent alive without recurrence at six month intervals up to five years. Primary operable group. Forty five patients, radiation alone or with palliative surgery. ———— Forty-one patients pre-operative surgery post-operative —o—o— Seventy-six patients surgery, post-operative — · · · · · Seventy-five patients surgery alone — · — · —

to point out that the percentage figures obtained by us when surgery alone was used are much lower than those reported by numerous other clinics

When we consider the duration of disease after treatment, as outlined in Table IV, we find that the cases treated by irradiation alone showed a longer average duration than any of the other three groups, while those treated by radical surgery alone showed the shortest duration

Age of the Patients—In the selection of patients for treatment by physical agents alone, we chose older women in whom operation seemed a more formidable procedure and in whom a trial with irradiation seemed justifiable. Surgical experience has shown that advanced age presents no unusual hazards in connection with radical amputation of the breast. Nevertheless, a major operation does loom rather large in the mind of the average patient sixty-five or seventy years of age, and much may be accomplished in such a case, by the growth restraint which follows irradiation.

When the patients in the primary operable series are classified according to decades, the results are shown in the following table

TABLE V
Age of the Patients
(Primary Operable Group)

Decades	Group A Pre-operative Irradiation Surgery Post-operative Irradiation	Group B Surgery Post-operative Irradiation	Group C Irradiation	Total
21-30	0	3	1	4
31-40	8	14	1	23
41-50	14	33	7	54
51-60	13	16	5	34
61-70	3	8	11	22
Over 70	3	0	11	14
	41 Patients	74 Patients	36 Patients	151
	15% over 60 7% over 70	11% over 60 none over 70	61% over 60 31% over 70	

This table shows that the irradiation group contained a striking preponderance of older women in whom the disease is usually less active and correspondingly less menacing. This group should have had a higher percentage figure of satisfactory five year results than the other two groups, but such does not prove to be the case. Therefore, the age comparison shows radiation alone at a disadvantage as compared with treatment by surgery and radiation combined.

But advanced age was not the only determining factor for the selection of cases for radio-therapy. Several patients suffering from intercurrent disease, such as diabetes, serious cardiac ailment and tuberculosis, were also chosen for treatment. A few patients rejected operation and some of the

RESULTS IN IRRADIATION OF MAMMARY CANCER

remaining were advised to rely upon irradiation methods for the control of the disease, as the clinical setting seemed favorable for use of physical agents

PATHOLOGICAL HISTOLOGY

Although adequate pathological data were at hand for making histological diagnosis in the pre-operative, surgical post-operative patients, tissue for pathological examination was obtained in but thirty-one patients (69 per cent) in the irradiation series. Consequently, no pathological diagnosis has been possible in one-third of the irradiation patients. In the surgical post-operative group, pathological reports on slides have been obtained wherever possible. Following is a table of the pathological types encountered in the primary operable group.

PRIMARY OPERABLE GROUP

Pre-operative Irradiation Surgery, Post-operative Irradiation		
Carcinoma Simplex		12
alveolar		8
fibro		5
Comedo Carcinoma		4
Adenocarcinoma		2
cellular papillary		3
sweat gland type infiltrating		1
arising in ducts		1
Paget's Disease		2
Carcinoma—type not stated		3
		<hr/>
		41
Surgery, Post-operative Irradiation		
Carcinoma Simplex		8
alveolar		5
duct carcinoma		1
fibro		21
sweat gland type		4
Comedo Carcinoma		2
Adenocarcinoma		11
cellular		4
papillary		1
papillary cyst		1
Squamous Cell Carcinoma		1
Carcinoma—type not stated		9
		<hr/>
		68
Irradiation Alone, or with Palliative Surgery		
Carcinoma Simplex		9
alveolar		4
fibro		5
sweat gland type		3
Adenocarcinoma		1
mucous		1
papillary		2
Paget's Disease		2
Carcinoma—type not stated		4
		<hr/>
		31

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Pre-operative Irradiation Surgery	
Carcinoma Simplex	2
fibro	2
Comedo Carcinocarcinoma	1
Adenocarcinoma	1
	—
	6
Surgery, Irradiation for Recurrence	
Carcinoma Simplex	1
Adenocarcinoma	2
Carcinoma—type not stated	1
	—
	4
Surgery Alone	
Adenocarcinoma	1
Irradiation (3 years later, Surgery)	
Carcinoma—type not stated	1

In the irradiation group sections have been taken, when it could be done without detriment to the patient's best interest. At times it was difficult to remove tissue from a tumor close to the skin without leaving, at the site of section, a small tract leading down to the tumor, adding the additional hazard of infection. Furthermore, such a procedure may disseminate the disease by floating tumor cells into adjacent lymphatics or venules. We are convinced that a clinical diagnosis of carcinoma of the breast, made without mental reservation, and corroborated by several competent surgeons, should not be questioned. Where a reasonable doubt exists as to the presence of cancer, a section should be taken or the tumor excised locally. This has been the rule in the present series.

It is difficult to grade histologically, according to degrees of malignancy the patients in the three major groups in the foregoing table. However one broad generalization can be made, namely that the irradiation patients had less malignant types of the disease, from the standpoint of histology than those treated by a combination of surgery and irradiation.

Palliative Surgery—In ten of the patients in the irradiation group, some type of palliative surgery was performed—A local excision, axillary dissection or palliative mastectomy. One may question the wisdom of placing such cases in the irradiation group. They were included because palliative surgery was incidental to the treatment by radiation. Palliative operations were done because ulceration was imminent or the tissue changes precluded further irradiation.

Adequacy of Radiation in the Irradiation Group—Despite the relatively poorer showing made by the irradiation cases, one may ask whether these patients received adequate radiation. Most of the treatment was given five or more years ago, and was necessarily empirical, as accurate data for dosage had not accumulated. Many patients were treated entirely by the old type, low-voltage X-ray machines, and much of the treatment was inadequate, in the

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light of our present knowledge Radium was, as yet, an untried agent, of great potency and some of the patients received over-dosage, with considerable damage to normal structures, others were given wholly inadequate treatment to properly care for the lesions. Irradiation has been passing through a process of evolution and final judgment concerning its efficiency must be withheld for several years.

The Comparative Efficacy of Radium and X-rays in the Irradiation Group—A comparison has been made in the following table of the end results of the patients treated entirely by radium, entirely by X-rays or by a combination of the two agents.

TABLE VI
Results in Primary Operable Cases Treated by Radium and X-rays

Group	Number	Alive	%	Alive but Recurrent	Dead	Dead of Intercurrent Disease	Lost Track of
Radium	11	5	60	1	4	1 [5-yr result]	0
X-rays	10 - 1 = 9	1	11	0	8	0	1
Combined (Radium and X-rays)	24 - 9 = 15	5	37	0	9	5 [one 5-yr result]	5

Radium appears the more efficient agent of the two, and the best results were obtained where radium alone was employed. Our most satisfactory results followed the treatment of small tumors in old women, by the implantation of glass tubes into the tumor, implanting 1 to 1.5 millicuries to each cubic centimetre of tumor tissue to be treated.

The following case histories illustrate the efficacy of various types of irradiation used simply or in combination.

Primary Operable Group (Treated by Radium Alone)

CASE No 167—L. S., aged forty-nine years, married, was admitted to the hospital on the service of Doctor Quick, May 9, 1919. She had never been pregnant. About May, 1917, a small, hard mass was discovered above the nipple in the right breast. The mass was painless and there was no increase in size until about eight months before admission. At this time she noticed occasional sharp pains in the region of the tumor.

Physical Examination—The patient was in good general condition. In the right breast, above and to the outer side of the nipple, was a hard mass 3.5 x 2.5 cm., with moderate skin fixation, but movable on the chest wall. There was no nipple retraction and no axillary lymph-nodes were palpable. A chest plate was negative for pulmonary metastasis. The patient was examined by several of the attending surgeons and a diagnosis of carcinoma of the breast was made without reservation. No biopsy was taken.

On June 17, 1919, six bare tubes of radium emanation, totalling 16 millicuries, were implanted in the tumor, a dose of 2112 millicurie hours. A like number of tubes with a similar dosage was inserted in the right pectoral fold.

A marked erythema, over the treated areas followed, with superficial ulceration at one point. Three months after treatment no mass could be palpated. The patient remains free from disease, eight years after treatment.

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Primary Operable Group (Irradiated by Radium and X-rays)

CASE No 173—C S, aged forty-five years, a widow, of American parentage, was admitted on December 8, 1920. She had never been pregnant, and there had never been any history of trauma. In July, 1919, she noticed a retraction of the right nipple. At times she had experienced slight pain in and about this region.

Physical Examination—She was a well-nourished woman. In the central portion of the right breast was an irregular, firm mass 11 x 11 centimetres with marked nipple retraction. There was slight skin fixation and the surface of the tumor was irregular. No nodes could be palpated. X-ray examination of the chest was negative for pulmonary metastasis.

Operation was advised, and a pre-operative cycle was given in December, 1920, consisting of four L V 1 treatments of the right breast and drainage areas. Upon reconsideration by the patient, she left the hospital deciding that she would not undergo operation. Later, through correspondence, the patient returned and decided to submit to treatment of her mammary disease by irradiation.

Examination made October 1, 1921, showed that the mass in the breast was a little larger, with the nipple drawn upward and outward to a still greater degree. The nipple had almost disappeared and about it was a reddened irritated skin. There were no palpable nodes in the axilla.

On October 12, 1921, she received a cross-fire with two radium packs. 8129 millicurie hours over the inner side of the breast and 8072 millicurie hours over the outer side. The distance was 6 centimetres and the filtration, 0.5 millimetre of silver and 2 millimetres of lead. On November 19, 1921, platinum needles were inserted in the tumor, giving 156 millicurie hours for each needle. On April 2, 1922, she received 9025 millicurie hours, a radium pick at 6 centimetres being applied directly over the anterior surface of the breast. No biopsy was done.

There was considerable immediate regression in the tumor, following each irradiation. No subsequent treatment has been used. The patient is now without evidence of active disease, six years and five months after the beginning of treatment.

Six patients were treated by local removal of the mammary tumor, preceded and followed by irradiation. Three of these have survived the five-year period without recurrence. An abstract of the case history of one of the satisfactory results obtained by this method is appended.

Primary Operable Group (Irradiated by Pre-operative Irradiation, Local Excision and Post-operative Irradiation)

CASE No 154—W O, colored woman, aged forty-six years, born in the United States, was admitted May, 1920. She was a widow and had had two lactations of nine months duration without unusual incident. Nine months prior to admission she noticed a small lump in the right breast. This was not painful but had steadily increased in size.

Physical Examination—The patient, who was obese, had a marked degree of aortic insufficiency. Examination of the upper, middle segment of the right breast revealed a hard mass, 3 centimetres in diameter. The mass was sharply defined but was somewhat fixed to adjacent breast tissue. There was no evidence of skin adherence and no axillary lymph-nodes were palpable. A chest plate was negative for evidence of pulmonary metastases.

At first, the patient rejected any operation because of her cardiac disease. A cycle of X-rays, consisting of four treatments of L V 1 was given over the right breast and lymph drainage areas. She was finally persuaded to submit to a local removal of the mass. This was done under novocain anesthesia on June 11, 1920, carrying this incision wide of the tumor through normal breast tissue. Doctor Ewing reported that the mass consisted of 4 cysts, each measuring 2 x 2 cm. The walls of the cysts were smooth and

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the cavities contained slightly blood-tinged serum. Microscopic examination revealed an adenocarcinoma with abundant stroma, probably arising in a cyst.

On June 23, 1920, a radium pack, containing 2053 millicuries of radium, was applied for six hours over the site of operation.

In February, 1922, a small firm node was palpable in the right axilla and a similar one in the right supraclavicular region, just behind the inner end of the clavicle. There was no other evidence of recurrence. From February 2 to March 16, 1922, a cycle of 4 treatments of L V 2 X-rays was given, covering the right breast and drainage areas. The patient has remained well and free from disease to date, seven years after treatment was begun.

Primary Operable Group (Treated by L V 1 X-rays Alone)

CASE No 160—O R, aged fifty-seven years, married, of English parentage, was admitted to the hospital, May 29, 1920. She had had one lactation with a duration of five months without untoward incident. Two years prior to admission, she was operated upon for uterine myoma. At this time, two small lumps were noted in the upper, inner portion of the right breast. These had not increased in size, but, at times, the patient complained of slight pain and itching in this region.

Physical Examination—The patient was well-nourished. In the upper, inner quadrant of the right breast was a horse-shoe shaped mass 5 x 3 centimetres. The surface was irregular and skin fixation was present. The nipple was retracted but there were no palpable axillary nodes. The chest plate was negative for metastasis.

Because of the slow growth of the tumor and the patient's willingness to submit to irradiation, the decision was made to treat the case entirely by irradiation, but to remove a section for microscopic study. From May 29 to June 9, 1920, four L V 1 treatments were given over the right breast and drainage areas. August 13, 1920, under novocain anæsthesia, a section was removed for histological examination. Doctor Ewing's pathological report showed the case to be one of carcinoma simplex. The wound healed by primary union.

From September 16 to October 11, 1920, five L V 1 treatments were given over the right breast and drainage areas and a similar series of treatments was given from November 12 to December 15, 1920. From February 24 to March 17, 1921, four similar treatments were repeated over the same areas. In February, 1921, seven months after admission, there was no evidence of disease in the breast. In July, 1922, two years and two months after treatment, rather diffuse telangiectases were visible over the right breast, and this condition has persisted and increased somewhat during the past few years. At the present time the patient is alive and well with no evidence of disease, seven years after the beginning of treatment.

Pre-operative Irradiation—Pre-operative irradiation in the treatment of mammary cancer has not been approved, generally. The reasons given for this attitude are (1) it necessitates a delay in surgical intervention, (2) irradiation hyperæmia may cause more active bleeding, (3) wound healing is less satisfactory, and finally better end results are not obtained.

Following pre-operative X-ray treatment, we have preferred an interval of three or four weeks before operation was undertaken. This delay has seemed justified, because irradiated tumor cells are rendered less viable, and irradiated tissues in the operative field become unfavorable soil for the growth of cancer cells, left or disseminated at the time of operation.

With an interval of three to four weeks between the time of the last X-ray treatment and operation, it has been unusual to meet active or troublesome bleeding. However, if the interval is shorter and the dosage employed

has been heavy, more disturbing hemorrhage may be expected. It should be noted that this unpleasant incident has been encountered in numerous cases in which irradiation was never used.

It has been our impression that wound healing has not been delayed following the pre-operative treatment which we have employed.

A series of cases reported to this Association by Doctor Herendeen and the writer in 1925, strongly suggested that where pre-operative irradiation had been used a higher percentage of recoveries could be expected. Our conclusions were based upon three year results, for data over a longer period had not accumulated. The present article permits a comparison of five-year results in a series of cases where pre-operative irradiation was employed or entirely omitted.

An inspection of Graph No. 1 shows that pre-operative irradiation has furnished a slightly higher percentage figure in five-year results than the groups in which preliminary irradiation was omitted. Upon the other hand, when Table IV is studied, it is evident that when pre-operative irradiation was used the average duration of life after treatment was six months longer than in the purely surgical group, and six months shorter than those receiving only post-operative irradiation.

A review of the type of pre-operative X-ray treatment given reveals that in two-thirds of the patients the L V 1 technic was employed. Moreover, in a large proportion of the patients the ideal interval of three to four weeks between irradiation and operation was not carried out. Frequently, one cycle of L V 1 X-rays, given in five to seven days, was followed a few days later, by radical surgery. Today we know that such treatment is far less effectual as a pre-operative measure than the technic employed in more recent cases.

Post-operative Irradiation—Less objection has been raised to the employment of post-operative irradiation than to the use of radiation, prior to surgery. None of the objections to pre-operative irradiation have seemed valid when post-operative irradiation was proposed. The writer has frequently outlined our reasons for employing post-operative irradiation routinely at the Memorial Hospital.

An inspection of Graph No. 1 shows that the patients in whom post-operative irradiation was used gave a percentage of five-year results which was much higher than in patients in whom this procedure was omitted. The five-year results, in the surgical post-operative group, shows 35 per cent alive and well, whereas, in the purely surgical group, but 15 per cent of recoveries was obtained. If we turn to Table IV, one will see that the duration of life after radical surgery alone was three years, while the duration in the post-operative irradiation group was four years and three months, representing a decided advantage in favor of post-operative treatment.

Moreover, we have usually confined the post-operative treatment to one or two cycles of four treatments each. More recently, we are giving three

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of four such post-operative cycles, which makes the treatment additionally effective

When we review the type of X-ray treatment given to our patients post-operatively, we find that two-thirds of them were treated by the L V 1 type of therapy, but this was frequently combined with the L V 2 technic. We believe that the post-operative irradiation, now in use at the Memorial Hospital, consisting of L V 2 on L V 3 types of treatment, for the two lower portions of the operated side, and high-voltage for the two upper areas, will give still better percentage figures.

OPERATIVE MORTALITY IN THE PRIMARY OPERABLE GROUP

In seventy-seven patients on whom radical operation was done at the Memorial Hospital there was but one operative death, the patient succumbing to pneumonia two weeks after operation. This is an operative mortality of 1.3 per cent.

PRIMARY INOPERABLE GROUP

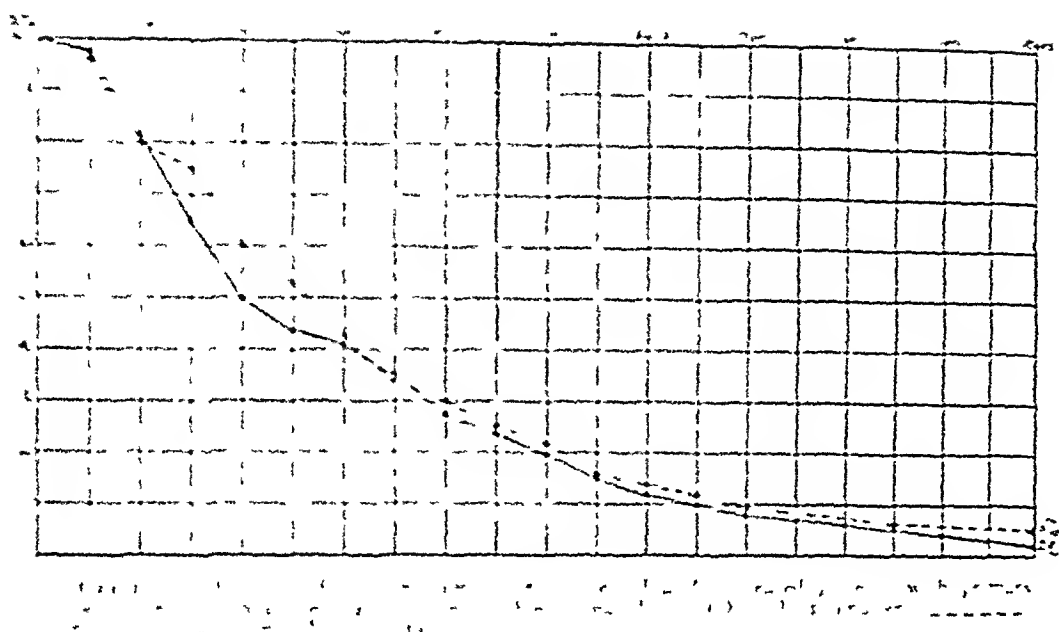
In two previous communications by the writer, in one of which Doctor Herendeen was associated, the general management of primary inoperable cases and the methods of irradiation employed were fully discussed. Every worker in this field has felt that an evaluation of the efficacy of irradiation in primary inoperable cancer of the breast could never be satisfactorily made until trustworthy data could be obtained upon the duration of the disease in untreated cases. Recently, a very interesting study made by Daland of 100 untreated cases has furnished the much-desired information. We have compared his series with a group comprising 133 of our own primary inoperable cases, treated by irradiation, with or without palliative surgery, and the results are interesting. The following table compares the two groups with respect to the average age at onset and the average length of life.

TABLE VII
Age at Onset and Length of Life
(Primary Inoperable Cases)

	Untreated (Daland)	Treated (Present Series)
Average Age at Onset	57.5 years	53.1 years
Youngest Patient	31 years	30 years
Oldest Patient	87 years	85 years
Average Length of Life	40.5 months	44.6 months

The average total duration of disease in the untreated series was 40.5 months, while in our own cases, treated by irradiation, the corresponding figure was 44.6 months. The patients, on the average, lived four months longer, where irradiation was used, than did the untreated cases.

When the Daland curve is plotted, showing the percentage of patients alive, at six months intervals, for a period of ten years, and our own results are similarly plotted, the two curves are as follows:



An inspection of this graph shows that the two curves are closely comparable, the Daland curve giving a higher percentage alive at the end of ten years than was obtained in our own series following treatment by irradiation.

One would conclude from a study of these two curves that irradiation is ineffective in altering the course of primary inoperable carcinoma of the breast. But such a conclusion is not fully justified. The major portion of the treatment was given prior to May, 1922, when our X-ray equipment was entirely low-voltage and most of these patients received only the L. V. type of treatment.

X-rays of this sort were more effective in dealing with superficial lesions but the important extensions of the disease to the axillary nodes and viscera reacted less favorably to this type of therapy. At first treatment was focused upon the palpable lesions while many metastatic areas received scant irradiation.

The following table shows the age at the onset of disease in the two series of cases.

TABLE VIII
Age at Onset of Disease in Primary Inoperable Cases

Years	Daland's Cases (103 Patients - Distant)		Treated Cases (124 Patients - Present Series)	
	Number of Patients	Percentage Age Group	Number of Patients	Percentage Age Group
55 or over	50	50	51	41
40-55	38	38	52	42
Under 40	3	3	21	17

Inspection of this table reveals that but 3 per cent of Daland's cases were in the age group in which highest malignancy is expected whereas 17 per cent

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of our own were so classified. Fifty-nine per cent of Daland's cases were fifty-five years or over, at which age the disease is relatively benign, but 41 per cent of our patients falling into this most favorable group. This comparison shows that the untreated patients probably had less menacing forms of cancer than our own.

Furthermore, thirty-seven of our patients (30 per cent) had an average duration of disease up to admission of four months, while sixty-nine (52 per cent) had an average duration of ten months. It is evident that a large number had rapidly growing tumors, dissemination occurring early. Seven of the cases were of the fulminating inflammatory type and two were associated with pregnancy. Two were also afflicted with cancer elsewhere, one patient having a cancer of the uterus and the other, cancer of the ovary. Four of our primary inoperable cases, who are alive and well today, cannot be included for comparison, as they have not yet survived the ten-year period from the beginning of symptoms.

The benefit to be expected from the treatment of such patients are relief from pain in the primary lesion and metastases to bone, healing of superficial carcinomatous ulcers, improvement in the patient's general condition, and, in some instances, a prolongation of life.

The rapidly fatal issue of a patient with a highly malignant tumor is illustrated in the following case history.

CASE No 254—K. H., was an unmarried Irish woman, forty-six years of age at the time of her admission in June, 1921. Six weeks prior to admission she began to suffer neuralgic pains in the right arm, associated with a sense of tightening in this extremity. These symptoms persisted for about two weeks, and then she noticed a small lump in the lower portion of the right breast. This mass increased in size rapidly, up to the time of admission.

Physical Examination—She was a poorly-nourished woman with the right breast completely replaced by a firm mass, 10 cm in diameter. The nipple was retracted, fixed and œdematous. There was marked skin adherence and complete fixation to deeper structures. Palpation revealed a continuous mass of tumor tissue running upward from the breast into the right supraclavicular space and the right side of the neck. The circumference of the right arm, below the axilla, was 2.5 centimetres larger than the left. The left breast showed considerable induration and a firm node was palpable in the left axilla. An X-ray plate of the chest revealed evidence of some enlargement of the nodes in the right hilum, with carcinomatous infiltration, extending along the bronchi.

A cycle of X-ray treatments, consisting of four exposures of L. V. 1 type was given over the right side, from June 9 to June 13, 1921. Six similar treatments were given to both right and left sides, from July 12 to July 19.

The patient failed rapidly and she was confined to bed under Social Service care. She developed severe pain in her lumbar and pelvic region and a persistent cough. She died at home September 21, 1921. The total duration of disease from the beginning of symptoms was five months.

Four patients, in our Primary Inoperable Group, are now without evidence of disease. History and treatment of one of these patients are abstracted below.

Primary Inoperable Group

Case No. 306—A single widow, of Irish parentage, aged sixty-five years, was admitted to the breast clinic July 14, 1919. She had had four lactations, the last one in 1893, the duration of each being 18 months. Twenty-nine years before admission an abscess in the right breast was opened and drained. Seven months prior to admission she noticed a small lump in the upper, outer portion of the right breast. The breast itself increased in size and for two months had been tender and painful.

Physical examination showed a woman in fair nutrition. There was a mass 7 x 7 centimetres in the upper, outer quadrant of the right breast. The nipple was retracted and somewhat fixed. The skin overlying the tumor was reddened and the breast was partially adherent to the chest wall. Several enlarged, hard nodes could be felt in the right axilla.

From July to December, 1919, the patient was treated by L. V. I. type of X-ray therapy, receiving, altogether, 19 treatments over the right breast and lymph drainage areas. In January, 1920, ulceration of the overlying skin occurred. A palliative mastectomy was done, January 15, 1920, dissection being carried down to the tissue overlying the pectoralis muscle. The wound was partially closed by sutures. Three weeks later the included area was covered with patch grafts, which took well and healed rapidly. Pathological examination of the specimen by Doctor Egan, showed a cellular carcinoma with very extensive vascular hydropic degeneration throughout the tumor. In October, 1920, in L. V. I. cycle was used over the right breast and drainage areas and this was repeated in December of the same year.

There has been no subsequent treatment and the patient is alive and well seven years and ten months after admission.

PATHOLOGICAL HISTOLOGY

Sections were obtained in seventy-three of the primary inoperable patients or 55 per cent. The pathological types encountered are indicated in the following table.

Primary Inoperable Cases

Carcinoma—Simplex	20
dycolar	9
fibro	13
sweat gland type	3
Adenocarcinoma	7
cellular	2
mucous	2
papillary cyst	1
sweat gland type	2
Carcinoma—type not stated	5
	<hr/>
	73

CONCLUSIONS

1. The treatment of carcinoma of the breast by irradiation methods, alone or combined with radical surgery, gives a higher percentage of good five-year results, than when radical surgery alone is employed.

2. Pre-operative irradiation adds to the percentage figures of satisfactory five-year results. High-voltage treatment should be employed, permitting an interval of three to four weeks between treatment and operation. Carried

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out in this way, bleeding at operation is not more active and wound healing is not delayed

3 Post-operative irradiation has increased the length of life after operation and has yielded a higher percentage of satisfactory five-year results, than when radical surgery alone was employed

4 Radium is a more effective agent than Rontgen-rays in dealing with this disease

5 Convincing evidence of the efficacy of physical agents in dealing with mammary cancer is furnished, first, clinically, by marked diminution in size or complete disappearance of the tumor, and second, by the gross and microscopical changes occurring in tumor tissue adequately irradiated

6 Although the Daland curve and our own are identical, a comparison of the two groups shows that our own primary inoperable cases were younger women and that more than 50 per cent of them had rapidly growing tumors, the cases becoming inoperable ten months from the onset

7 Treatment of primary inoperable cancer of the breast by radiation gives relief from pain, healing of superficial carcinomatous ulcers, improvement in general condition and prolongation of life

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GASTROSTOMY IN CARCINOMA OF THE ESOPHAGUS⁴

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ONE of the most tragic and discouraging consultations referred to the surgeon is cancer of the esophagus. In 1913, Chevalier Jackson¹ stated that the mortality of malignant diseases of the esophagus was at that time 100 per cent. Eleven years later Jackson² reiterates "malignant diseases of the esophagus with its 100 per cent mortality is one of the greatest reproaches to surgery today. In almost all other fields at least a few cases are cured." Today he may still repeat the above with justification.

Cancer of the esophagus is not a rare disease. Only uterine, mammary and gastric malignancy exceed it in frequency in the general cancer incidence. In England and Wales there were 15,000 deaths from this cause during the ten years 1911-1920 (Souttar).³ Clayton,⁴ in analysing 5900 autopsies performed in the past five years at the Philadelphia General Hospital, found 812 cases of malignancy, and of these, 41 (5.05 per cent) died of carcinoma of the esophagus. Vinson⁵ reports 154 cases studied at the Mayo Clinic in two years. In a group of 600 cases of carcinoma of the gastrointestinal tract studied by Friedenwald, Zimm and Feldman,⁶ 128 (21.3 per cent) were of the esophagus. These facts bring out forcibly the importance of Jackson's statements.

Until rather recently nearly every writer on the subject of esophageal cancer has advocated gastrostomy for inoperable cases, and practically, this has meant nearly all. (Ch. A. Egberg⁷ a Norwegian surgeon, was apparently the first (1837) to advocate gastrostomy in the cases of stricture and diverticulum of the esophagus. The operation was performed on animals by Bassow in Russia in 1842, and by Blondlot in France in 1843 for the purpose of studying the physiology of digestion (Senn).⁸ Sedillot⁹ in 1849 first performed the operation on a human being and it was by him that the term gastrostomy was coined. There then followed twenty-eight successive deaths before the first successful case was performed in 1875 by Sidney Jones¹⁰. This case lived forty days and was for carcinoma of the esophagus. This success was shortly followed by Verneuil's¹¹ case in 1876. By 1884 Gross⁹ was able to collect 207 cases of gastrostomy, 167 of which were for cancer of the esophagus, and of these 117 (70 per cent) died in one month and 81 per cent in three months. One case lived twelve months and one case thirteen months. In 1897, John Ashhurst¹² collected 189 additional cases with a mortality of 51.7 per cent.

* Read before the joint meeting of the Philadelphia and New York Academy of Surgery, February 8, 1928.

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Ashhuist opposed the operation in malignant disease, believing that the risk was so great and the possibility of gain so slight as not to recommend it. Earlier, Gross¹ favored it at an early stage of carcinoma but says, "its adoption on the other hand, when death is imminent from exhaustion and starvation, is a species of refined cruelty reflecting no credit on surgery." Through the years the same trend of thought prevailed, one technical method succeeding another until the advocates of radium and intubation appeared.

Dilatation by sound and bougies of œsophageal strictures, whether carcinomatous or not was the usual method of treatment before the days of gastrostomy. Probably the foremost advocate of this type of treatment at present is Vinson of the Mayo Clinic. In 1923⁵ he reported 125 cases of carcinoma of the œsophagus, treated by this method with three deaths and an average duration of life of five months. The diagnosis in these cases presumably was made on the history, the passage of sounds and X-ray, since he states that, "œsophagoscopy is of limited value in diagnosis and treatment." We agree with Jackson² when he says, "there are only two means by which an early diagnosis of œsophageal malignancy can be made, namely, (1) Rontgen-ray examination and (2) œsophagoscopy. All other means are late, inconclusive and some of them dangerous." Presumably also Vinson's cases were somewhat selected since both in this paper and in 1925¹³ he lists certain types that are unsuitable for this procedure and for which he recommends gastrostomy. This is important in considering mortality figures and average length of life.

The advocates of radium used by itself have apparently decreased in recent years. Stone¹⁴ at the Memorial Hospital, New York, did not find a single case that can be said to have been cured by radium although there was some temporary improvement in many of the cases. In the discussion that followed Hedblom, Case, Meyer, and Heyd were equally pessimistic. Wassink¹⁵ reports one case in forty-one living two and one-half years after application. Guisez,¹⁶ who has had extensive experience in the use of radium, reports a case of a man, aged sixty, who reported to him in November, 1911, with the history of six months difficulty in swallowing. Œsophagoscopy showed what was apparently a malignant growth the size of a five franc piece, a few centimetres above the cardia. Biopsy diagnosis was epithelioma. This man had several applications of radium and in January, 1926, then seventy-five years of age, was apparently well and had no more difficulty in swallowing.

Intubation, of necessity, entails previous dilatation in most cases. Souttar³ in reporting 100 cases of œsophageal carcinoma gives results as follows: in fifty cases of intubation he had seven deaths (14 per cent) and average duration of life in twenty-six followed cases of 5.3 months. In twenty cases of gastrostomy he had seven deaths (35 per cent) with an average duration of life in ten followed cases of 3.6 months. In his seven immediate deaths following intubation the œsophagus was torn in one and perforated in another. In one case he had to give up his intubation due to hemorrhage from the growth during manipulation. In some cases the stricture was

impassable and could not be intubated. In at least one case growth was too high for intubation, and in several cases the tube had to be replaced. In general, in looking over his table of cases, one gets the definite impression that his gastrostomy cases were much the worse risks and would not be expected to survive any procedure as well as his intubation cases. Myerson¹⁷ another advocate of the intubation method reports four of his cases one of whom lived sixty-nine days, another twenty-nine days, a third still living at the time of his report, and the fourth 117 days.

In this clinic we have practised gastrostomy almost routinely. In view of the great difference in the immediate mortality of the other palliative measures as briefly reviewed above and gastrostomy it seemed to us worthwhile to stop and consider. Our series is admittedly small but completely studied and with one hundred per cent follow-up. Our study did not cause us to alter our method of treatment for reasons we will bring out. The above facts are our only excuse for adding to the immense literature on this subject.

During the period September 1, 1922 to January 15, 1928 there were a total of thirty-six cases of gastrostomy done on Division B with ten deaths, a mortality of 27.8 per cent. Of these twenty-one were for carcinoma of the esophagus with six deaths, a mortality of 28.5 per cent.

TABLE I
Gastrostomy Cases, Division B
September 1, 1922 January 15, 1928

	Care	Deaths	Mortality
Carcinoma esophagus	21	6	28.5
Carcinoma fundus	2	0	
Stricture esophagus	7	2	
Carcinoma cheek	1	0	
Sarcoma mediastinum	1	1	
'Vicuous circle' post-operative	1	1	
Carcinoma pharynx	1	0	
Carcinoma larynx	1	0	
Laryngeal paralysis	1	0	
	<hr/> 36	<hr/> 10	<hr/> 27.8

A glance at Table I discloses the fact that the gastrostomy mortality for the total series is essentially the same as in the cancer series. Therefore it may be assumed that the carcinoma of itself is not the chief feature in the high mortality but extraneous conditions. For example—in our non-cancer series we had two deaths in strictures. One was due to the fact that, after the patient left our service the gastrostomy tube was cut off and the proximal portion allowed to fall in the stomach in the belief that this would be passed. Instead of this, the tube plugged the pylorus and the child died of acute dilatation of the stomach. The other case was a man in very bad condition, with myocarditis, hypertrophied prostate and B U N of 88, who died from his cardio-vasculo-renal disease. The other two cases are self-explanatory in the table.

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TABLE II

Gastrostomy, Division B
Hospital Deaths—Carcinoma Œsophagus

Hospital No	Case	Lived	
495	I	2 days	Œsophageo-tracheal fistula
7399	VI	5 "	Œsophageo-tracheal fistula
833	II	15 "	Autopsy Perforation œsophagus
4588½	IV	16 "	Œsophagus exposed in neck at same time
5066	V	21 "	Œsophagectomy 19 days later
1126	III	24 "	Leakage Jejunostomy 16 days later

The following is a brief summary of the record of the fatal cases

CASE I—No 495 Male, age fifty-three Admitted to the Medical Service November 22, 1922, with a six months' history of increasing dysphagia and marked loss of weight He had cough with profuse foul sputum An X-ray showed œsophageo-tracheal fistula The leucocyte count 19,100 He was transferred to the surgical service November 28, 1922, and gastrostomy under local anæsthesia done that day The lungs filled up and death occurred November 30, 1922 The autopsy showed a large carcinoma of the œsophagus, just below the bifurcation of the trachea with perforation of the left bronchus, with metastases to the liver, pancreas, and abdominal lymph-nodes The left lung showed gangrene and cavitation Microscopic section showed a squamous carcinoma, grade 4

CASE II—No 822 Male, age fifty-eight Admitted to Bronchoscopic Service January 15, 1923, with a note that he lost twenty-seven pounds in the past three months No other history X-ray January 18 showed obstruction in the lower and middle third Œsophagoscopy showed ulceration of the thoracic œsophagus, 4 centimetres above the diaphragm The full extent of involvement below was not explored Biopsy specimen showed squamous carcinoma, grade 3 He was transferred to Surgical Service January 25, 1923, gastrostomy done on the same day Died February 7, 1923, and autopsy showed an acute peritonitis, apparently from perforation but no metastases Autopsy specimen also showed squamous carcinoma, grade 3

CASE III—No 1126 Male, age fifty-five Admitted to Surgical Service March 12, 1923, with a history of dysphagia dating back to June, 1922 July 1, 1922, constriction shown by X-ray July 24, 1922, œsophagoscopy by Doctor Jackson showed narrowing of the lumen lower third and hard projecting white mass on the anterior wall Biopsy—squamous carcinoma, grade 2 Dysphagia for solids continued but did not increase, and there was only moderate loss of weight A few days before admission dysphagia became absolute Gastrostomy March 13, 1923, under local and gas anæsthesia Owing to defect in gastrostomy technic, much leakage occurred Weakness developed and death occurred April 6, 1923—twenty-four days after operation No autopsy

CASE IV—No 4588½ Male, age sixty-two Admitted to the Surgical Service November 10, 1924 One year previously had substernal pain and "sticking" of food Dysphagia increased In September, 1924, had operation for gall-bladder in another hospital Aphonia developed about one month later and dysphagia increased Loss of weight sixty pounds X-ray showed constriction lower end of the œsophagus Œsophagoscopy showed an ulcerating, fungating mass 36 centimetres from the upper teeth that seemed to surround completely the œsophageal lumen Biopsy showed squamous carcinoma, grade 2 Slight irregular fever each day Gastrostomy November 15, 1923, under gas ether anæsthesia Œsophagus explored in neck and iodoform gauze passed beneath it An excision of the œsophagus was intended later Gastros-tomy worked well but fever continued, and patient became irrational Blood trans-fusion November 20, 1924 Pulmonary œdema developed and death occurred December 1, 1924, sixteen days after operation Autopsy showed annular constriction of the œsophagus a short distance above the diaphragm An ulcerative area about 3 centimetres in

width extended almost through the wall of the œsophagus, which ruptured when traction was put on it. No metastases. Lungs showed emphysema and œdema of the lungs, kidneys arteriosclerotic, and pericardium showed acute fibrinous pericarditis.

CASE V—No 5066 Male, age fifty-one. Transferred from Medical Service January 23, 1925. Dysphagia of one year duration. Dull substernal pain. X-ray showed partial obstruction in thoracic œsophagus at the level of the third thoracic vertebra. Œsophagoscopy showed an area of infiltration that projected forward from the posterior œsophageal wall in a thick fold 25 centimetres from the upper teeth. Biopsy showed squamous carcinoma. Patient in good condition, gastrostomy January 24, 1925, under local and gas. Recovery uneventful and patient did well. Evisceration of the œsophagus February 12, 1925, Torek method. Death February 15, 1925—sixty hours after second operation and twenty-one days after gastrostomy. Autopsy specimen showed squamous carcinoma, grade 3.

CASE VI—No 7399 Male, age sixty-eight. Admitted to Bronchoscopic Service October 15, 1925, with a story of six weeks difficulty in swallowing and at the time of admission was unable to swallow without severe, violent coughing attacks, in which he brings up the substance swallowed. Diagnosis of carcinoma of the œsophagus which had perforated into the trachea made and gastrostomy done immediately under local anæsthesia. His condition never varied. Œsophagoscopy. He died following an attack of vomiting with pulmonary aspiration on morning of October 20, 1925. Partial autopsy obtained and diagnosis verified but record lost.

Comment—Of these six deaths, two should be charged against œsophagectomy since undoubtedly the operations on the œsophagus caused the death and not gastrostomy. The two cases that had œsophageo-tracheal fistulæ would have died under any method of treatment. No 822, Case II again would have died under any method of treatment, since the lesion perforated. We wish to point out that in this series where gastrostomy was done without selection of cases, the high mortality is due, in part at least, to the fact that, certain cases that would have died under any method of treatment (excluding the œsophagectomies), as for example the œsophageo-tracheal fistulæ, are barred from other palliative methods. We believe that a simple gastrostomy in a similarly selected group of cases should be practically as safe as other methods of treatment.

TABLE III
Gastrostomy Division B Recovered Cases
Carcinoma Œsophagus
Cases that lived less than 6 months

Hospital No	Case	Lived	
5052	VII	20 days	Emergency operation
8618	VIII	26 "	Marked anemia
4652	IX	30 "	Marked aphonia
2381	X	52 "	Died—œsophagectomy
5073	XI	73 "	Died—Pneumonia
4875	XII	100 "	Probable lung metastases—(X-ray)
5339	XIII	136 "	Abscess lung (X-ray)

CASE VII—No 5052 Male, age forty, who had only two months symptoms and was admitted on the evening of February 7, 1925, in extremis. He was operated upon that night as an acute emergency and therefore had no X-ray or œsophagoscopy. He improved somewhat after his operation but died at home February 27, 1925, twenty days after his operation.

CASE VIII—No 8616, was a man of fifty-eight years, who had had symptoms for

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one year and was greatly emaciated and in precarious condition Complete dysphagia Hæmoglobin 30 per cent X-ray elsewhere showed complete obstruction of the œsophagus Due to his condition he was operated on immediately without any further studies He improved definitely after operation, gained in weight, so that he was able to go home, but then went rapidly downhill and died twenty-six days after operation

CASE IX—No 4652 Male, sixty-one years Symptoms thirteen months Aphonia five months Marked loss in weight Achylia X-ray showed lesion involving lower two or three inches of œsophagus Biopsy by œsophagoscopy adeno-carcinoma, grade 2 Gastrostomy October 30, 1924, under local Patient's general condition improved, gained in weight and strength but aphonia increased Died at home November 30, 1924

CASE X—No 2381 Male forty-eight Symptoms one month Admitted November 10, 1923 in good condition X-ray—obstruction lower end of the œsophagus just above diaphragm Œsophagoscopy showed fungating ulcerating mass 34 centimetres from upper alveolus Biopsy—squamous carcinoma Gastrostomy and thoracotomy November 17, 1923 Patient did very well Improved and returned for œsophagectomy Died following œsophagectomy January 8, 1924, fifty-two days after gastrostomy Specimen showed squamous carcinoma, grade 2

CASE XI—No 5073 Male forty, with five months symptoms X-ray partial obstruction—lower thoracic Œsophagoscopy fungating mass 35 centimetres from upper teeth Biopsy—squamous carcinoma, grade 4 Improved temporarily Died seventy-three days after operation of what was said to be pneumonia

CASE XII—No 4875 Male, fifty-eight Symptoms of two months Loss of weight, fair condition X-ray showed stricture upper thoracic œsophagus and diagnosis confirmed by œsophagoscopy post-operatively Slide lost X-ray of chest and physical examination showed probable lung metastases Patient continued to lose weight despite gastrostomy and died about 100 days after operation

CASE XIII—No 5339 Male, thirty-four Six months symptoms Emaciated X-ray—obstruction mid-thoracic œsophagus Chest X-ray showed lung abscess with considerable cavitation Œsophageo-tracheal fistula could not be demonstrated Œsophagoscopy before operation could not be done because of a constriction at the level of the crico-pharyngeal fold Retrograde œsophagoscopy post-operatively showed marked induration in fungating mass mid-thoracic œsophagus Biopsy squamous carcinoma, grade 4 After gastrostomy patient improved and was sent home He died 136 days after operation apparently from his pulmonary condition

Comment—In this group, again, the patients were in wretched condition to begin with In Case VII (No 5052) gastrostomy had to be done immediately or allow the patient to die without any treatment Any other palliative treatment was out of the question Case IX together with Case IV in Table I showed a marked aphonia This seems to be a bad prognostic sign

TABLE IV
Gastrostomy Division B Recovered Cases
Carcinoma Œsophagus

<i>Cases that lived over six months</i>			
Hospital No	Case	Lived	
4604	XIV	204 days	
4224	XV	270 "	Onset slow 3 months previously diagnosed ulcer
1181	XVI	305 "	Radium used 18 days later
10212	XVII	350 "	
3242	XVIII	360 "	Died suddenly while fairly well
4276	XIX	392 "	Good for 9 months

CASE XIV—Was living 204 days post-operatively but in a rather precarious condition due to bilateral recurrent paralysis which interfered with his cough mechanism. He died probably shortly after this as these people do from drowning in their own secretions.

CASE XVI—No 1181 Had an application of radium eighteen days after gastrostomy.

CASE XIX—No 4276 Was perfectly comfortable and happy for nine months and gained weight. He then began to have pain in his back and chest and some hæmatemesis.

Two cases are still living at the time of this report. One, No 11695, is living 142 days after his operation. The gastrostomy is working perfectly but he complains of pain in his back and legs. The other, No 12371 is still living seventy-one days after his operation and is about to return for œsophagectomy.

Discussion—In this series we have twenty-one cases of proved carcinoma of the œsophagus on whom gastrostomy was done with six deaths, a mortality of 28.5 per cent. This does not compare favorably with Vinson's figures of 125 cases treated by dilatation and bouginage with only three deaths, nor with Souttar's series of fifty cases treated by the intubation method with seven deaths (14 per cent). However, if we excluded the two cases where we manipulated the œsophagus and the two cases of œsophago-tracheal fistulæ, which are barred from the other treatment, we have seventeen cases of gastrostomy with two deaths, a mortality of 11.8 per cent.

Fifteen cases survived the operation, two are still living and the remainder had an average duration of life of six months. Vinson reports average duration of life of five months and Souttar's followed-cases average duration of life of five and three-tenths months. If we excluded Case VII an acute emergency which could not have been treated by other methods, and Case X, the œsophagectomy case, it gives us eleven cases and average duration of life of seven months. Of these eleven cases, six survived over six months, the longest being thirteen months.

The objections to gastrostomy have been the high primary mortality, the increased length of stay in the hospital, and the objection of the patient to being fed through the gastrostomy tube. We believe that we have partially explained the high mortality. The increased length of stay in the hospital should not be considered if we can obtain better results. Discomfort to the patient in regard to feeding cannot be avoided. The objections to dilatation and bouginage have been well summarized by Jackson^{2, 18}. The fact that Vinson has had so few complications does not mean that, if this method became popular, everyone would be as successful, as is shown in the report of Friedenwald and Morrison¹⁹. The advantage of the other methods, of allowing the patient to swallow, is sometimes only temporary. At times, following gastrostomy, as many have pointed out, the œsophagus after some rest will again allow liquids and soft foods to go by.

When we consider the effect on the lesion itself there can be no question of the superiority of gastrostomy over dilatation or intubation methods. Our Bronchoscopic Service has frequently seen marked improvement in the local

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lesion following the test that is given to the œsophagus, and, what is perhaps most important, the gastrostomy allows us, if the condition of the patient warrants it, at a later date to attempt a radical removal, admittedly the patient's only chance for cure of his lesion.

The statistics of this small series may be of interest. The ages vary from thirty-nine years to sixty-eight years of age, an average of fifty-three and eight-tenth years. They were all males. Three of the six patients over sixty years of age died in the hospital but none of the six under fifty. With one or two exceptions the dysphagia was of long duration and only twice did the condition of the patient warrant proceeding with œsophagectomy. Evidently Jackson's² statements should be broadcasted. He says that asphyxia, dysphagia, pain, weight lost, hæmatemesis, emaciation, and cachexia are all hopelessly late symptoms. Every patient mentioning the slightest abnormality in swallowing, or even slight abnormal sensation in the cervical, retrosternal or epigastric region should be considered possibly cancerous and examination with X-ray and œsophagoscopy urged.

By X-ray or œsophagoscopy the lesion was located in the upper third in three cases, in the middle third in seven cases and the lower third in nine cases. All the slides were recently reviewed and graded by Dr. A. E. Bothe, according to Broder's classification. Of fifteen cases reviewed twelve were squamous cancer, and three adeno-carcinoma, the adeno-carcinomas all being in the lower end of the œsophagus. Seven were grade 2, three grade 3, five grade 4. The average total duration of life was for the grade 2, seventeen months, grade 3, eight and one-quarter months, and one still living, grade 4, ten months. Clayton⁴ found of thirty-nine cases studied, three of grade 1, with an average duration of life sixteen months and one of which had extensive metastases, fifteen cases grade 2, duration eight months, five cases with extensive metastases, twelve cases grade 3, duration five months, five cases with extensive metastases, and nine cases grade 4 duration three and one-half months, all with extensive metastases. It seems as if this grading may be of some value in selecting the case for œsophagectomy.

SUMMARY

1. An analysis of twenty-one cases of gastrostomy for proved carcinoma of the œsophagus is presented.

2. The hospital mortality was 28.5 per cent. If the œsophagectomies and those that could not have been treated by other palliative methods are eliminated the primary mortality was 11.8 per cent.

3. The average duration of life of the cases that survived was six months, with two still living. If the œsophagectomies and those that could not be treated by other palliative methods are eliminated, the average duration of life was seven months.

4. The patients were all males with an average age of fifty-three and eight-tenths years. Only twice did the condition of the patient warrant proceeding with œsophagectomy.

MULLER AND BRILL

5 The grading of the biopsies with Broder's classification may be of some value in selecting cases for oesophagectomy

SUMMARY OF CASES

Hosp No	Sex and age	Duration	X-ray	Oesophagoscopy	Survival days	Remarks
495 F S	M 53	6 mos	oesoph trach fistula	none	2	Autopsy—sq ea grade 4 with exten metastases
822 E B	M 58	3 mos	obstr lower third	ulcer 4 cm abov diaph	13	Autopsy—sq ea grade 3, no met
1126 R M B	M 55	9 mos	obst 8 & 9 thor	strict low third	24	Biopsy sq ea grade 2
4588½ H W	M 62	1 yr	constr lower end	ulcer 36 cm	16	Autopsy—sq ea grade 2, no met oesoph exposed in neck
5066 J F	M 51	1 yr	obstr third thor	lesion 25 cm	21	Excision oesoph 19 days after gastrostomy Spec sq ca grade 3
7399 M S	M 68	6 wks	none	none	5	Oesoph trach fistula—autopsy record lost
5052 J S	M 40	2 mos	none	none	20	Pt in extremis Emergency op
8618 C M	M 58	1 yr	outside	none	26	Hæmoglobin 30 per cent Precarious cond Operated immediately
4652 C G	M 61	1 yr	3" from car-dia	lesion lower end oesoph	30	Biopsy, adeno-carc grade 2
2381 T V	M 48	1 mon	obstr lower end	fungating mass, 34 cm	53	Oesophagectomy
5073 S K	M 40	5 mos	obstr lower thoracic	fungating mass, 35 cm	73	Died of pneumonia
4875 J D	M 58	2 mos	strict upper thoracic	yes	100	Specimen lost Unimproved by gastrostomy
5339 J U	M 39	6 mos	mid-thor abs rt lung	retrograde	136	Constriction at crico-pharyngeal fold Biopsy—sq ea grade 4
4604 J D	M 64	11 mos	Comp obstr upper third	Infiltration 25 cm	204	Bilateral recur paralysis
4224 S F	M 64	8 mos	obstr third thoracic	stenosis mid third	270	Slide lost
1181 L S	M 57	2½ mos	obstr third rib	fungating ulcer, up end	305	Sq ea grade 3, one radium appl 18 days post-gastrostomy
10212 I K	M 42	2 yrs	2" above diaphragm	fungating mass, 34 cm	350	Adeno-ca grade 2, post-op atelectasis both lower lobes
3242 C N	M 59	6 mos	obstr first thoracic	large ca cervical	360	Sq ca grade 4 Died suddenly while fairly well

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SUMMARY OF CASES—*Continued*

Hosp No	Sex and age	Duration	X-ray	Oesophagoscopy	Survival days	Remarks
4276 H S	M 53	4½ mos	obstr mid-thoracic	fungating mass, 30 cm	392	Sq ca grade 2 Happy for 9 mos
11695 W C	M 59	3 mos	obstr middle third	none		Still living after 142 days
12371 J P	M 40	2 mos	obstr lower third	fungating mass, 38 cm		Still living after 71 days, returning for oesophagectomy

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OPERATIVE RELIEF OF CARDIOSPASM WHERE DILATATION HAS FAILED¹

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IT HAS been shown by Plummer¹ and Vinson and their co-workers at the Mayo Clinic that only a small percentage of cardiospasm cases fail to respond to dilatation when the hydrostatic dilator can be passed through the cardia

There are certain cases, fortunately few in number, where the most expert are unable to pass the cardia even with the aid of modern armamentarium, and the assistance of surgery by the transgastric route for primary dilatation is necessary before hydrostatic dilatation can be carried out. There is also a certain percentage that recur within six months after dilatation. These excepted cases should be amenable to the operative procedure to be described.

While the real etiological factors in cardiospasm are uncertain and confusing, the diagnosis of this condition has been sim-



FIG 1—Barium filled dilated esophagus before operation

plified by the use of the X-ray and the opaque meal, but judging from the many transabdominal procedures still advocated for relief of these cases, it is evident that the surgical methods in use are not entirely satisfactory.

The operative procedures heretofore recommended include the different forms of cardioplastics, all requiring a free opening in the stomach and consequent liability to infection, even when the cardia is accessible without turning

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OPERATIVE RELIEF OF CARDIOSPASM

up the costal margin. Extramucous cardioplasty although minimizing the dangers of infection is not always practicable in a long, narrow thorax, without displacement of the costal margin. Plications of the œsophagus in the mediastinum have been advocated by Willy Meyer² and Reisinger,³ but have not been successful. Invagination to produce shortening of the œsophagus within the mediastinum through an external exposure at the base of the neck has been used with success by Freeman.⁴ The literature contains numerous ingenious transabdominal procedures for enlarging the cardia, which includes the application of mechanical force, either with protected forceps or the fingers as in Mikulicz's operation. As an opening in the stomach is always necessary for these procedures, the possibility of infection cannot be eliminated.

Whether the immediate relief obtained by the patient in this case was due to the division of the constricted area or to the straightening out of the elongated, convoluted œsophagus cannot be definitely determined, but judging from the reports of the radiologist, the sat-

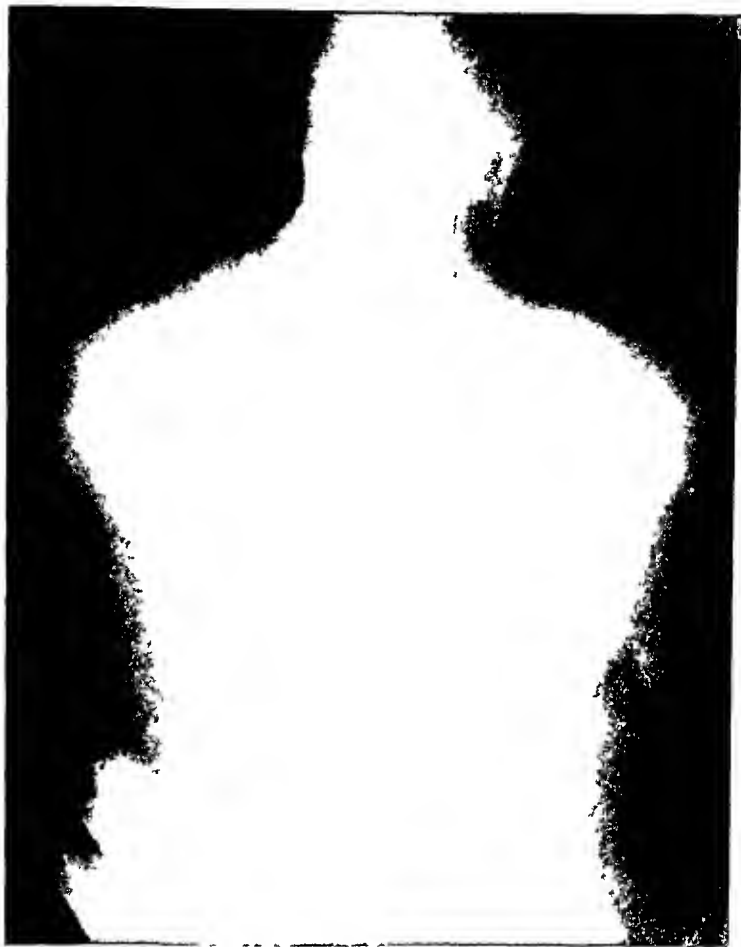


FIG 2—Barium retention in œsophagus six hours after meal

isfactory clinical outcome and the local œsophageal changes reported by the œsophagoscopist it is presumed that either or both procedures have a field of usefulness in the treatment of those cases that fail to respond to the non-operative type of treatment.

CASE REPORT—J. R. M., age thirty-five, white, unmarried, American male, veteran of the World War and a former member of the United States Marine Corps, was admitted to the Walter Reed General Hospital, August 1, 1927. He complained of pain and distress beneath the lower end of the sternum after eating, accompanied by a choking sensation and regurgitation of the food swallowed. He also complained of weakness, inability to gain weight, and a mild constipation.

The patient stated that he was always in good health until the winter of 1924, while he was still in the Marine Corps, when he began to experience sharp, stabbing pains beneath the lower end of the sternum coming on suddenly, immediately after meals. These attacks occurred irregularly at first and lasted from five to ten minutes. There was no vomiting and the symptoms were not relieved by either food or alkalies. He slowly lost

weight and grew progressively weaker. After four or five weeks, he sought dispensary treatment and was sent to hospital where he remained nearly five months. During this time he had a constant feeling of weight beneath the sternum and occasionally vomited. He gradually reached the point where he was hardly able to swallow his food. After he was returned to duty he became a cook and in this position he was able to prepare special foods for himself and take plenty of time to eat. Under this regime he managed to get along fairly well. During 1926, he was again hospitalized and operated upon in January, 1927, for bilateral inguinal hernia. By this time he swallowed only with great difficulty, either liquid or solid food and he had lost considerable weight, being reduced to 110 pounds from previous weight of 140, his best weight at the beginning of his illness. As

he was considered unfit for further duty with the Marine Corps, he was discharged from the service in June, 1927, as a result of a medical survey.

At the time of his admission to Walter Reed the patient was ambulatory and afebrile. He appeared physically inferior, was poorly nourished, with dull, worn facies and exhibited a visceroptotic habitus. He was 67½ inches in height and weighed 113 pounds without clothing. The tonsils were atrophic and he had periodontoclasia with alveolar resorption of all his teeth. His chest was narrow, shoulders sloping and expansion poor. The manubrium was prominent, the lower end of the sternum depressed and the intercostal angle acute. On auscultation of his heart, an occasional extrasystole was



FIG. 3—Posterior sutures in place

heard and his blood pressure taken while seated was only 110 millimetres for the systolic with a diastolic of 70. The abdominal wall was thin and sagging, and he had marked visceroptosis. There were no masses nor any tenderness detected. He had a right, recurrent, indirect, incomplete, inguinal hernia and the right testicle was atrophic and soft. The liver and spleen were not enlarged. The patient appeared mentally dull and his response was slow. The muscles were generally soft and lacked development, and he had second degree flat feet.

X-ray examination of the gastro-intestinal tract showed an obstruction of the lower end of the œsophagus, with marked dilatation of the œsophagus above the obstruction. The barium filled œsophagus was 6.5 centimetres in width, regular in outline and ended at the hiatus in a smooth, cone-shaped shadow as shown in Figure 1. Six hours after the meal the œsophagus contained about one-third of the barium ingested, as in Figure 2, and at this time the stomach was empty and all the barium which had passed through the intestines was concentrated in the cæcum. None of the barium remained in the œsophagus twenty-four hours after the meal. Examination of the chest showed an irregular, calcified, paratracheal lymph-node on the right side and there was no evidence of a mediastinal growth. Normal response followed the intravenous administration of tetraiodophenolphthalein-sodium salt.

OPERATIVE RELIEF OF CARDIOSPASM

Œsophagoscopy showed a roughened, hobnailed, macerated area which bled easily, 23 centimetres from the upper incisor teeth or at about the level of the arch of the aorta. Below this point the œsophagus was distended into a sausage-shaped pouch, the mucosa was thickened and macerated and a little turbid fluid was present. The œsophagoscope was advanced with difficulty by raising shoulders and flexing the head. At the forty-sixth centimetre level the bottom of the pouch was reached, but the examining instrument could not be introduced through the narrowed orifice into the cardia of the stomach.

Examination of the blood showed a coagulation time of four minutes, 90 per cent hæmoglobin and 13,500 leucocytes, the polymorphonuclear cells amounting to 63 per cent. The Wassermann reaction and Kahn test were negative.

The tonsils were removed under local anæsthesia, August 25, 1927. The patient received belladonna constantly in one cubic centimetre doses, three times daily before meals for three months and bromides intermittently, with little or no benefit.

On October 15, 1927, the œsophagus was dilated to 55 F (17 millimetres) under local anæsthesia, and on November 10 another œsophagoscopy was performed under local and an unsuccessful attempt was made to dilate the spasm. December 28, under gas-oxygen-ether sequence, the œsophagoscope was passed. There was some difficulty in passing the crico-pharyngeus. A small amount of food was aspirated and a 20 F bougie was introduced through the hiatus and the œsophagoscope passed with little difficulty over the bougie to a point 52 centimetres from the upper incisor teeth. Upon withdrawal of the instrument no

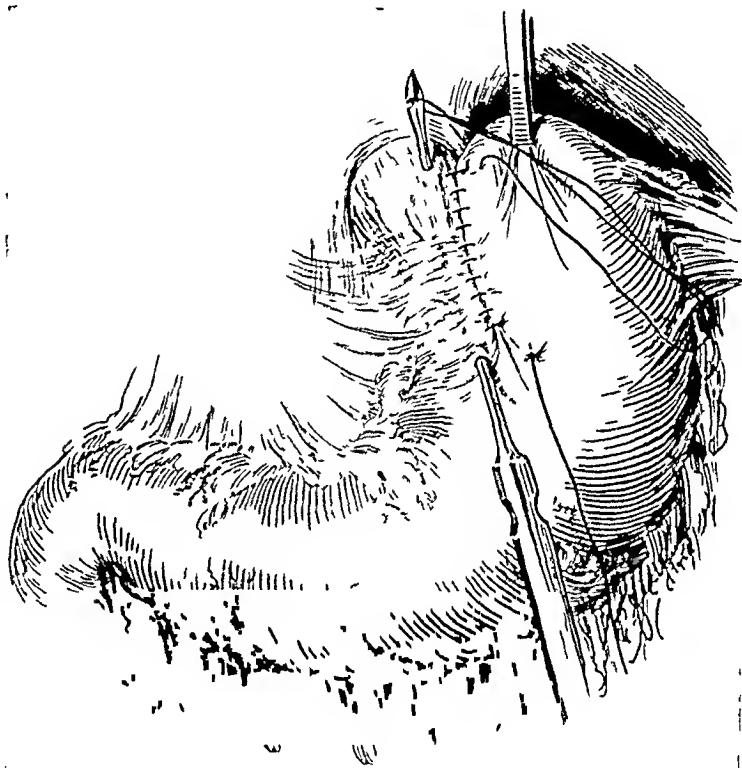


FIG 4.—Introduction of ligature

lesion of the surface was seen. Following the dilatation a small stomach tube was passed easily for several days and the patient was fed through the tube, but soon this was no longer possible and the treatment was abandoned. Since the patient had shown no permanent improvement and he had even more difficulty in swallowing than before dilatation, he was transferred to the surgical service, and on January 24, 1928, under nitrous-oxide-oxygen-ether anæsthesia, an operation was performed for the permanent relief of his cardiospasm.

Operation—A high, left, paramedian incision was made with the patient in the reversed Trendelenburg position. The stomach was not contracted but the cardia was high and somewhat inaccessible owing to the anatomical conformation of the thorax which was long and narrow. The cardia was loosened from its diaphragmatic attachment, and the freedom of the œsophagus in the mediastinum permitted it to be drawn down about two inches. A thickened, contracted area was evident at a point above where the diaphragm was detached and this contracted area did not disappear when an attempt was made to invaginate the stomach wall through it with the index finger. The cardiac end of the stomach was freed from its splenic attachment sufficiently to permit its being attached to the drawn down œsophagus close to the diaphragm by two rows of sutures.

placed longitudinally such as are used for the posterior sutures in the first stage of a Finney pyloroplasty (Fig 3) The first row of sutures passed through the peritoneum on the stomach side and the superficial muscular layer on the œsophageal side The second row passed through the peritoneum and muscular layers on the stomach side and the muscular layer on the œsophageal side

If the left vagus is in the field of operation it should be pushed aside, and if the œsophagus is not sufficiently tortuous and elongated to cause lengthening of the left vagus, the vagus should be divided

A Reverdin needle threaded with heavy, silk fishline was then passed from below upward into the stomach parallel to the suture line and a short distance to the left of it, to emerge from the stomach near the diaphragm where it was unthreaded and withdrawn It was reintroduced unthreaded, in a similar manner at the right of the suture line to emerge from the œsophagus above the spasm area and close to the diaphragm Here it



FIG 5 —Stomach wall drawn over buried ligature (puckering by ligature not demonstrated)

was again threaded, using the upper end of the fishline, and withdrawn, the two ends then being tied after the method of the old McGraw elastic ligature to include the tissues to be divided (Fig 4) The strength of the fishline enables it to be tied with sufficient force to ensure complete devitalization of the tissues included If rapid division of the tissues included in the ligature is thought necessary, a rubber band one-eighth inch in diameter can be included in the carrier with the fishline and secured under tension after the ligature is tied After the fishline ligature was tied, the stomach wall was drawn over in front of the area where the ligature had been tied and sutured to the œsophagus in front so as to completely bury

the fishline ligature (Fig 5) A small Dakin tube was introduced under the diaphragm on the right side and another placed on the left side The wound was closed in layers The patient was placed in bed in the Fowler position

Following the operation no food was given by mouth for seven days, but the patient received 2,000 cubic centimetres of normal saline solution intravenously each day and an abundance of nutritive fluids per rectum by Murphy drip The drainage tubes were removed on the fifth day

One month after the operation X-ray examination showed a marked *diminution* in the size of the œsophagus There was only slight delay in the passage of the barium through the hiatus, which was slightly narrowed Ten minutes after the meal a very small amount of barium was visible in the lower end of the œsophagus and there was only a trace after thirty minutes There was slight irregularity in the outline of the stomach at the site of the œsophageal opening Two months after operation œsophagoscopy was performed without anæsthesia and the tube introduced to 49 centimetres The œsophagus was no longer dilated, the mucosa was clean, smooth and pinkish in appearance and there were no food particles present The site of the operation could not be seen but there was

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FIG 6—Slight interruption in passage of barium after operation



FIG 7—Absence of barium ten minutes after meal



infolding of the mucous membrane suggestive of it. The œsophageal wall closed normally over the tube as it was withdrawn and the surface was easily seen throughout.

X-ray examination nine weeks after operation showed that there was no œsophageal dilatation and but slight delay in the passage of the meal at the hiatus, as shown in Figure 6, the œsophagus being completely empty ten minutes after the meal (Fig. 7). There was an apparent increase in the size of the œsophageal opening and slight irregularity in the outline of the stomach at the location of the enlarged opening.

It is a well-recognized fact that the best criterion of the success of a procedure is the condition of the patient. Five weeks after operation he had gained eight pounds and three months after, at the present writing, he weighs 134 pounds, a gain of twenty-one pounds over his admission weight and in the words of the Ward Surgeon as transcribed in his progress notes, "The patient has made an uneventful recovery. He takes all articles of food without distress and with evident enjoyment."

The operation is not offered as a substitute for the non-operative treatment of those forms of cardiospasm which are dilatable by an expert and which do not recur. But, it is pointed out, experts are not always available, and what constitutes an expert in the use of the hydrostatic or other forms of dilatation is not easily determined. Certainly the handling of from five to ten cases spread over a number of years does not indicate expertness in any field and especially in this one where individual genius is often a determining factor. There is a recognized low mortality and 25 per cent recurrence during the first six months with the non-operative treatment in the hands of an adept, but judging from recent publications,^{5, 6} the mortality is higher and the percentages of recurrence greater with those of more limited faculties. These are some of the factors that must influence the surgeon when he is compelled to decide between an operation such as this, on the one hand whereby danger of infection is minimized and which can be carried out under direct visual control supplemented by palpation, and, on the other hand, the different forms of dilatation performed by those of limited experience.

If further use of this method shows that all varieties of cardiospasm respond to this form of treatment, it will be possible for the general surgeon, who cannot always command the services of a specialist, to handle such cases with a reasonable assurance of success and a low mortality.

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MORTALITY FACTORS IN ACUTE APPENDICITIS *

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BEGINNING with the year 1886, when Fitz of Boston first coined the term "appendicitis" and published his memorable article, this disease for the next few years held the centre of the stage as far as surgical articles in the press and discussions at surgical meetings were concerned. In 1887, Morton of Philadelphia is reported to have deliberately performed the first appendectomy in the States. In 1889, McBurney wrote his epochal paper describing the point of tenderness which now bears his name, that was and too often, even to-day, is supposed to exist in all acute appendicitis cases. In 1894, Fowler made his great addition of the "Fowler position" and during the next ten years such masters as J. B. Murphy, Ochsner, Deaver, Richardson, etc., wrote many articles on this important subject. Since 1915, however, relatively few contributions on the subject have been made to the literature. In fact the thoughts of the physician and surgeon have been directed toward the discussion and investigation of whether subtotal gastrectomy or gastro-enterostomy is the best treatment for duodenal ulcer, or should a gall-bladder be removed, or simply drained. It is a strange coincidence that the mortality from acute appendicitis is reported to have risen since this same year—1915. Murat Willis¹ states that according to vital statistics the mortality of this disease in the United States has risen 31 per cent since 1915. It further appears in literature that in Canada also the death rate has increased from this condition. One province quotes the increase as 8 per cent. In Alberta, Canada, deaths from appendicitis rose from 125 in 1923 to 136 in 1924. In England, Short states that deaths from appendicitis rose from 69 per thousand population in 1913 to 74 per thousand in 1923. It is difficult to ascribe this increase to any one particular cause. Probably the fact that appendicitis is no longer, generally speaking, considered a major surgical condition, and that the simple procedure of appendectomy has lost its terrors, and to-day is undertaken by hundreds of inexperienced operators as lightly as they undertake an amputation or a herniorrhaphy, accounts for some of the increase. Credence is to be given this idea because although the countrywide mortality at the hands of the vastly

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increased number of inexperienced surgeons is higher, yet at the same time, that of the big clinics and experienced men has decreased. The statistics quoted by Geery³ throw much light in this direction.

Another probable cause is the fact that in the past many of the end results of neglected appendicitis were charged not to appendicitis mortality, but to perinephric abscess, liver abscess, septic pneumonia, typhoid fever, etc. To-day the fluoroscope has shown us that a pleural and pneumonic reaction may not be a septic pneumonia but due to a subdiaphragmatic abscess or a liver abscess, conditions rarely recognized before 1915 as being of appendiceal origin. To-day deaths from such are charged to appendicitis, and deaths they will be when encountered by the casual or inexperienced surgeon. It is one thing, as one surgeon aptly puts it, to remove a chronically diseased appendix from a thin abdomen, and quite another to do an appendectomy on an extremely obese woman with a gangrenous and ruptured appendix lying in the pelvis or retro-colic and high under the liver. Be the cause what it may, statistics show that the deaths occur in those cases where the diagnosis is delayed until the disease is no longer confined to the appendix. The fact that in simple or uncomplicated acute appendicitis, mortality figures in large series range from 5 per cent to 1 per cent, whereas 8 per cent to 14 per cent mortality is charged against appendicitis complicated by rupture, abscess, peritonitis, pylephlebitis, etc., tends to confirm this opinion. Ashhurst⁴ Added to this is the fact that as König states 18 per cent of acute appendicitis cases are admitted to the hospital with an incorrect diagnosis. It would seem therefore that the efforts of physicians should be toward early diagnosis. For that reason the writers have analyzed this group of 675 acute cases so proven by the laboratory reports and gross specimens. No cases of mistaken diagnosis or in which an innocent looking appendix was removed despite the pre-operative diagnosis of acute appendicitis, have been included in this series. Furthermore the diagnosis of peritonitis is limited to those cases with widespread lymph deposits on inflamed gut. Cases of abscess with cloudy fluid only are classed as "appendicitis with abscess." This explanation may possibly account for the fractionally higher mortality percentages in some instances. These have all been operated upon under one technic by the writer or one of his assistants, who have had varying degrees of experience. By the technic is meant that the same principles were carried out in all of them, namely, that as soon as a diagnosis was made the case was operated upon, that means *every* case was operated upon provided rigidity overshadowed distention and provided that the vascular system was still competent, a low blood pressure associated with a high temperature and cold extremities always contraindicate operation. There was one such case. Those cases that would fall in the group of delayed operation described by some surgeons were opened under local anæsthesia and a drain placed in the pelvis, no attempt being made to remove the appendix unless it presented in the wound. In this series we considered

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only one case too sick to attempt a simple drainage treatment, based upon the experience that relief of great abdominal distention results in immediate improvement if it be only temporary as it often is. These figures, therefore, may be representative of work performed by, we will say, five surgeons of different skill and experience but under the same conditions.

Perusal of the following tables, I think, will show that it is the atypical case that produces the mortality because the diagnosis is not made until the case ceases to be a simple appendicitis. In this connection it may be well to briefly outline the typical case. In such the symptoms follow a definite sequence.

Primary Pain—Pain of a colicky or cramp-like nature with more or less general distribution, begins rather suddenly and continues and increases in intermittent waves. At this period there is no rigidity or tenderness. This pain reaches its maximum usually in the first four hours (Birnie) and is complained of in the epigastrium or around the umbilicus.

Primary Nausea and Vomiting—These follow the primary pain within an hour or two and continue for a short time only.

Secondary Pain and Tenderness—At this time, four to eight hours after the onset of the disease, the pain, now more or less constant with exacerbations, becomes localized at "McBurney's point" and is associated with tenderness and muscular rigidity in this region. The vomiting has now ceased.

Shortly after the pain (two to six hours) there is some rise of temperature, usually around 100° – 101° . The rate of the pulse is somewhat increased and there is an increase in polymorphonuclear leucocytes. There is a tendency to constipation and the patient is usually restless. Any case that deviates from the above is more or less atypical. Livingston in his recent analytical table on acute appendicitis found that typical pain occurred in 75 per cent, nausea and vomiting in 70 per cent, rise of temperature in 67 per cent, local rigidity in 59 per cent and leucocytosis in 76 per cent of the cases. In other words only 69+ per cent of the series were typical. Our series will approximate this very closely. For the purpose of study the cases have been considered from the standpoints of

Age—In numerous places in the literature reference has been made to the fact that acute appendicitis is chiefly a disease of youth and early adults. One author states that 50 per cent of the cases occur under twenty years of age. Muller and Ravdin⁶ report on fifty-eight children, the youngest four years of age. In their series 34.4 per cent⁸ occurred in the first ten years. In Alexander's series 49.2 per cent occurred between the sixth and tenth year. Peterson⁸ in a group of sixty-two cases, 75 per cent of which were acute, found 60 per cent had perforation or abscesses. He quotes a mortality of 9.67 per cent in children and states that appendicitis under five years of age is not at all uncommon and that under two years of age it is overlooked. The condition occurs in earlier life but infrequently fortunately, for the per cent of delayed diagnoses is extremely high (90

per cent drainage in cases under three years) with a resultant high mortality—10 per cent. Maes⁷ finds the same conditions prevailing at the other extreme of life. He states that after fifty years the mortality is high (10 per cent). In our series shown below the same conditions obtain.

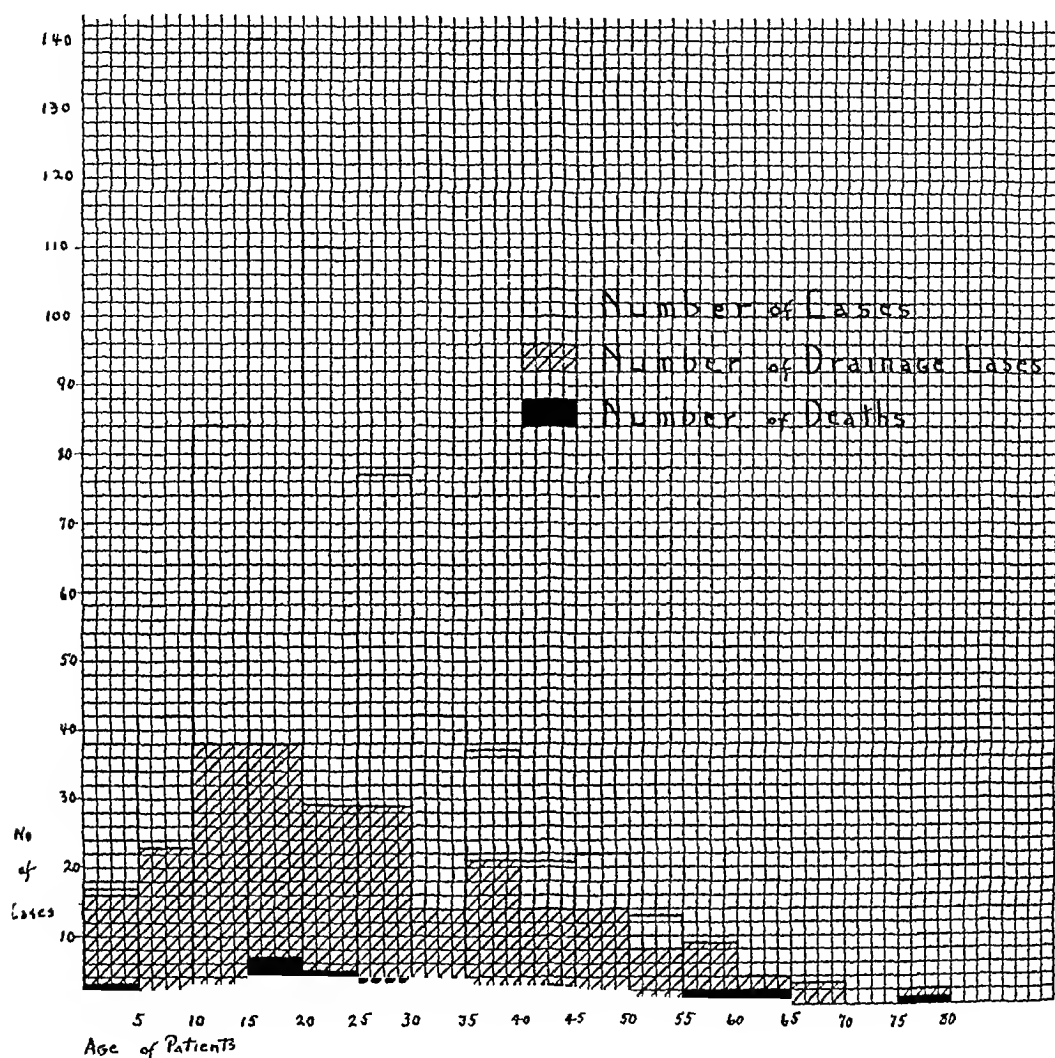


CHART I Showing the relation of age drainage and mortality

It will be noted that in this series the incidence of drainage is highest at the two extremes of life. Under five years drainage was necessary in 94.1 per cent of the cases and after fifty-five years of age, drainage was necessary in 100 per cent of the cases and mortality increases to 27.8 per cent. The period of lowest drainage per cent was between twenty and twenty-five years of age, namely, 26.3 per cent. Thus we see that drainage was necessary in at least one in every four cases, even those ages in which appendicitis is most often suspected. Our youngest patient was twenty months old, 2.7 per cent of our cases were five years or younger, and 9.4 per cent of the series were ten or under. Our mortality of 8.4 per cent in this latter group compares well with the figures of Peterson.

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TABLE I
Per cent of Damage Cases According to Age

Age		Age	
0-5	94 1%	40-45	66 6%
5-10	54 7%	45-50	63 6%
10-15	45 2%	50-55	61 5%
15-20	27 1%	55-60	100 %
20-25	26 3%	60-65	100 %
25-30	37 2%	65-70	100 %
30-35	33 3%	70-80	100 %
35-40	56 6%		

McBurney's Point Symptoms—Many of the cases of delayed or erroneous diagnoses are due to the fact that too much importance has been attributed to pain, tenderness and rigidity at this historical point. As quoted above, Livingston found typical pain and rigidity in only 75 per cent of his cases and local rigidity in only 59 per cent of the cases. In other words, only three out of every four cases have the sign we were all taught to be indicative of acute appendicitis. It is the experience of us all to have the physician diagnose a retro-colic appendicitis as pyelitis or a pelvic appendicitis as "indigestion."

Gladstone and Wakeley⁹ observed the position of the appendix in 3000 cases and found the appendix in the pelvis in 27.5 per cent and 69.2 per cent post-cæcal and retro-colic. Morison¹⁰ states that the pelvic appendix is very common and misleads the diagnostic experts in that it gives no right-sided symptomatology. In our experience the pelvic appendix most often gives epigastric pain and rectal tenderness with some tenderness over and rigidity of the extreme lower end of the right rectus abdominis muscle. Pressure over this area frequently gives the patient pain in the epigastrium. The following table illustrates the McBurney point fallibility.

In a series of 468 cases, only 44.7 per cent had pain at McBurney's point, whereas 31 per cent had rectal pain and tenderness. It will interest us also to find that in the pelvic cases 16.9 per cent had epigastric pain. Examination of the last column shows the high incidence of rectal tenderness in all cases, an evidence of soiling of the peritoneum at least. Pain in the left pelvis invariably means either a pelvic abscess or peritonitis. It must be borne in mind that appendiceal or "secondary pain" and tenderness is present at site occupied by appendix, *i e*, a retro-cæcal appendix gives loin pain and tenderness, a pelvic appendix gives rectal pain and low rectus rigidity and tenderness, etc.

TABLE II
Relation of Position of Pain to Location of Appendix

Position of appendix	Loin	McBurney	Bel ant sup spine	To rt of umbilicus	Epigastric	Total	Rectal
Rt. of cæcum	45 1%	49 %	5 %			51	13 7%
Below cæcum		84 6%	15 4%			103	23 3%
Left of cæcum		30 1%	9 6%	60 3%		73	23 2%
Retro-cæcal	39 4%	45 4%	15 2%			99	18 %
Pelvic		20 4%	61 9%		16 9%	142	57 %
Totals	13 2%	44 7%	27 3%	9 4%	5 1%	468	31 4%

In this next table of 480 cases, 30.2 per cent of the cases had the appendix in the pelvis

The column in the table headed Post Cases was made from consecutive autopsies on other than appendicitis cases at the Philadelphia General Hospital

TABLE III
Position of Appendix—Operated Cases

	Cases	Per cent	Post Cases
Right cæcum	52	10.8%	
Left cæcum	75	15.6%	33%
Below	109	22.7%	
Retro-cæcal	99	20.6%	32.4%
Pelvic	145	30.2%	10.7%

The relation of the position of the appendix to abdominal rigidity was very interesting. It will be noted at least one-fifth of the cases had no rigidity, at least no mention of it was made in the history report. When the appendix lay to the left of the cæcum and tucked under the ileum just over the brim of the pelvis in what we have fancifully termed the swallow nest position, rigidity was absent in 34.2 per cent of the cases. In our experience those patients displayed the most rigidity in which the appendiceal inflammation extended by contiguity to the abdominal wall. And on the other hand, when the diseased appendix was covered by bowel or omentum so that the abdominal wall was not involved in the early inflammatory process, rigidity was not a prominent symptom until later when the disease process had spread to the general peritoneal cavity.

TABLE IV
Relation of Position of Appendix to Presence of Rigidity

Position of appendix	No. of cases	Rigidity	No rigidity
Right of cæcum	49	79.6%	20.4%
Left of cæcum	76	65.8%	34.2%
Below cæcum	106	78.3%	21.7%
Retro-cæcal	98	82.7%	17.3%
Pelvic	140	78.6%	21.4%
Location unknown	138	76.8%	23.2%
Totals	607	77.2%	22.7%

Nausea and Vomiting—These symptoms do not always occur, appearing in only about 70 per cent of the cases according to reports. It is most often absent in the pelvic, 25 per cent, the retroperitoneal, 34 per cent, and the extra-cæcal, 30 per cent, type of disease. When it does occur it frequently happens as the immediate result of some medication, most often a cathartic taken by mouth. It is never a prominent symptom and may appear but the once. If present, however, it does not persist after the first

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few hours, at which time the pain has become localized. Should it recur later (secondary vomiting) it is an indication that there is a spread of the disease beyond the appendix itself, either into the peritoneum or the portal system as a pylephlebitis.

Vomiting is not a dependable sign, being especially unreliable in children and old people. In fact none of the objective signs indicate the gravity of the situation in the aged.

Examination of the next table discloses the relation of nausea and vomiting to the position of the appendix. In 596 cases nausea and vomiting occurred in 68.2 per cent. Nausea and vomiting were absent in 20.6 per cent of all the cases and this absence was most frequent when the appendix lay to the right and outside the cæcum and next when it lay to the left of the cæcum and beneath the ileum.

TABLE V
Relation of Nausea and Vomiting to Position of Appendix

Position of appendix	Nausea and vomiting	Nausea only	No nausea and vomiting	Cases
Right cæcum	63.5%	9.6%	26.9%	52
Left cæcum	67.0%	7.0%	25.7%	70
Below cæcum	73.6%	10.4%	16.0%	106
Retro-cæcal	70.3%	11.0%	18.6%	91
Pelvic	66.4%	11.2%	22.3%	143
Location not known	67.1%	14.9%	17.9%	134
Total group	68.2%	11.1%	20.6%	596

Temperature—Here again we have an unreliable sign. In reported cases it is present in from 67 per cent to 70 per cent and in most cases it reaches under a 100.5 per cent. This is so noticeable that high temperatures—103°–104° in adults—should direct attention to extra-peritoneal conditions such as pneumonia, pyelitis, endometritis, influenza, etc., especially when associated with a real chill. According to Colp¹¹ a chill during the incipience occurs in about 5 per cent to 7 per cent of the cases regardless of the type or extent of the pathology at that time. Of these 5 per cent about 5 per cent develop pylephlebitis. He found but little difference in the mortality of those with and without early chill. Eighty-eight per cent of those of pylephlebitis gave a history of ante-operative chill. In our series of 675 cases there were thirty with chills (4.8 per cent) with a mortality of 10 per cent. Of these eight had abscesses, seven general peritonitis and one a phlebitis.

The high temperatures occur in the retroperitoneal cases and those cases occurring during or immediately following pharyngeal or respiratory infections.

The question of increase of temperature likewise is of interest here. In 586 cases it is noted that (169) 28.8 per cent had temperature below 99°, (299) 51 per cent had temperature between 99° and 101° and only (118) or 20 per cent had fever of 101° and over.

TABLE VI
Temperature—586 Cases

Below 99°	99° to 101°	101° and over
169 cases 28.8%	299 cases 51%	118 cases 20%

Leucocytosis—Here again is an untrustworthy single sign. Leucocytosis of 8000 or more is absent in 20 per cent of cases. Yet a low count as is well known is not necessarily a good omen. In one of our cases a count of 5000 with a normal T P R were associated with a gangrenous appendicitis. These cases with a low leucocytosis and a high temperature always did badly.

In this series 570 had leucocyte counts. Of these 106 (18.6 per cent) were below 10,000 and 252 (44 per cent) were between 14,000–18,000.

Leucocytosis

Below 10,000	18.6%	106 cases
14,000 to 18,000	44.0%	252 cases
Total cases	570	

Cathartics—It was thought in the beginning of this report that the mortality in cases of cathartics would be much higher than those without cathartics, but our figures do not show much difference. The time element is the important one. A cathartic given at the onset of the disease will probably do little harm if the patient has his appendectomy within twelve to fourteen hours, again harking back to the early diagnosis. Cathartics administered early or late with delayed operation probably are responsible for some complications and mortality. It is best therefore to resort to enema as it is safest and what is more to the point does not confuse the issue.

Perforation—It has been the experience of the senior writer that perforation occurs very rapidly in certain types of cases. Acute appendicitis concurrent with acute tonsillitis progresses rapidly and perforation may occur in ten to twelve hours. The other type that perforates early is that in which the ulceration occurs near the base of the appendix. These cases are extremely dangerous because of the fact that protective adhesions do not form and walling off never occurs, consequently a general peritonitis and death is the result if early intervention is not undertaken. In this last type case the pain frequently begins locally over the appendix and does not occur as generalized or umbilical pain at all. The appendiceal colic due to fecalith obstruction gives this same type of pain.

The next table is of much interest. It will be noted that the highest incidence of peritonitis was in the second twenty-four hours. It is also of note that approximately 50 per cent of the cases, namely 300, did not reach the surgeon until in the third day and that 34 per cent did not reach the surgeon until the fourth day, which period gives the highest mortality—12.7 per cent.

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TABLE VII

Relation of Duration of Disease to Mortality, Drainage, Peritonitis and Abscess Formation

Day of disease	No of cases	Died	Drainage	Peritonitis	Abscess
1	235	2 5%	26 0%	8 0%	3 8%
2	122	10 6%	48 0%	26 0%	14 0%
3	69	7 2%	52 0%	11 0%	28 0%
4	47	12 7%	53 0%	10 6%	36 0%
5	24	12 5%	41 0%	12 0%	25 0%
6	14	7 1%	57 0%	14 0%	35 0%
7	30	6 6%	66 0%	10 0%	46 0%
7 +	44	4 5%	66 0%	6 8%	59 0%

Treatment —When a diagnosis is made of acute appendicitis operation should be performed at the earliest possible moment, unless the patient has a low blood pressure, a high temperature with cold extremities and distention predominating over rigidity associated with diminished pain and a silent abdomen Ashhurst very properly states that to delay operation in acute appendicitis is to gamble with death Furthermore, although delay may not result in peritonitis, it may result in abscess which if neglected causes pressure necrosis and a fecal fistula later In cases of doubt as to whether an acute or some other infection in the appendix or some other adjacent organ is the cause of the peritonitis, an operation should be undertaken, because of the fact that 75 per cent of acute right-sided peritonitis is due to appendicitis in adults and in children this per cent is even higher In other words a patient exhibiting persistent colicky pain followed by nausea and vomiting, localized tenderness and rigidity and pulse hurry should direct one's attention to surgery It is safer to remove 100 normal appendices than to let one perforate

These cases were all operated upon, at once, most of them through a grid-iron or muscle splitting incision, many of them under local anæsthesia and the appendix was removed whenever possible, which was in all cases in which it could be recognized Drainage was by means of Mikulicz and split tube drains, when necessary, in the pelvis at the site of the abscess and in peritonitis cases outside the cæcum up toward the liver The post-operative treatment is a pint of 2½ per cent sod bicarb and 5 per cent glucose given by bowel on the operating table in all cases In peritonitis cases the Ochsner treatment was carried out with the addition of a constant massive flaxseed poultice to the abdomen The fluids used by bowel are Murphy drip of first pint tap water with dr 11 of tinc digitalis, second pint 2½ per cent sod bicarb, and third and subsequent pints 5 per cent glucose If bowel is unretentive salt solution or even 5 per cent glucose in 1/32 per cent novocaine solution is given by continuous hypodermoclysis In very ill patients, continuous intravenous is used

Complications —Examination of the table below discloses the fact that peritonitis and intestinal obstruction lead the field In the treatment of the latter an early enterostomy under local anæsthesia was practiced By early

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enterostomy is meant when abdominal pain associated with tumultuous show-ers of peristalsis were not relieved by enema and change of position To combat pulmonary complications a pneumonia jacket and camphorated oil rubs are augmented by instructing the patient to take ten deep inspirations every hour Chewing gum or fruit lozenges are given as a preventive against parotitis

TABLE VIII
Complications in 675 Cases

	No	%	Died	%
Peritonitis	27	4 2	22	3 5
Secondary abscess	4	0 62	2	0 46
Pylephlebitis and liver abscess	7	1 25	3 (1) *	0 62
Fecal fistula	3	46	(two healed)	
Intestinal obstruction	12	1 8	7	1 08
Secondary hæm	1	0 15	1	
Phlebitis	4	62		
Embolus	1	15		
Pneumonia	8	1 25	2 (1) *	46
Atelectasis	3	46		
Pyelitis	3	46		
Parotitis	2	30	1	15
Acidosis	1	15		
Table death	1		1	
Unopened			1	

* See next table

TABLE IX
Mortality

	675 Cases	%
Total group	37 (3) *	5 3 (9)
Deaths		
Cause of death		
Peritonitis	22	3 2
Intestinal obstruction	7	1
Residual abscess	2	2
Liver abscess	3 (1) *	0 4
Pneumonia	3 (1) *	0 4
Table death	(1) *	1 +
Parotitis	1	1 +
Unoperated	1	

* These three deaths one with multiple liver abscesses diagnosed before operation a second with pneumonia at time of operation and the third a death on the table ten minutes after start of operation we think are fairly excluded from an acute appendicitis death With these excluded acute appendicitis in our hands gave a real mortality of 5 5 per cent The undrained cases gave a mortality of 1 07 per cent Total operated cases gave a mortality of 5 3 per cent (9)

SUMMARY

This series is a post-operatively and pathologically proven number of acute cases treated under one technic These are all the acute appendicitis cases admitted to the senior writer's service in the last few years and with the exception of one, were all operated at the earliest possible moment This one case was moribund and hence not operated upon The series, therefore, is a true analysis of the treatment of all acute appendicitis cases during that period in

MORTALITY FACTORS IN ACUTE APPENDICITIS

the hands of one senior and four junior surgeons with experience varying from three months to three years. Three years is the length of service in the surgical fellowship at the University of Pennsylvania. Eliminating one death on the table and one case of multiple liver abscesses (ten days duration) diagnosed before operation, the mortality was 5.5. One other mortality, that of a child admitted to the hospital with a temperature of $104^{\circ} 2$ with a right-sided pneumonia, so diagnosed by the pediatricist, and a coincident ulcerative appendicitis. Although the patient had cloudy fluid there was no perforation and the death was a pulmonary one. Eliminating this pre-operative pneumonia case, the mortality could fairly be said to be even lower.

From sixty to seventy per cent of cases in this series were atypical in one or more of the symptoms. This leads to difficulty of diagnosis which means in turn delay. Delay is shown to increase the mortality enormously, chiefly because of abscess, peritonitis and intestinal obstruction.

Peritonitis was diagnosed as such when the intestines were inflamed and showed organizing lymph patches. The mere existence of cloudy fluid did not warrant such a diagnosis. Peritonitis was the greatest factor in the mortality, intestinal obstruction was second. There was only one permanent fecal fistula, a tuberculous appendicitis and typhlitis.

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THE GIBSON-MIKULICZ DRAIN IN ACUTE APPENDICITIS

WITH REPORT OF 1588 CASES

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THE question of drainage of cases of acute peritonitis is still one of the problems of surgery concerning which there is a diversity of opinion. There is as yet no general agreement not only regarding when and when not to drain, but also concerning the type of drain to be used. Doctor Gibson¹ first reported his use of this drain in 1916 and² described it in 1921. Also in 1921, Doctor Farr³ reported a group of cases of acute appendicitis with peritonitis in which this drain was used. The purpose of this report is to amplify and bring up to date the last-mentioned paper and includes in its statistics the cases reported at that time.

The Gibson-Mikulicz drain has been used on the First (Cornell) Surgical Division of The New York Hospital for over fifteen years and as its advantages have become more apparent, has at the present time almost entirely replaced all other forms of drainage in cases of peritonitis. As there has been no change made in the drain itself, Gibson's original description is quoted:

"A square of rubber dam of suitable size is folded two or three times in the form of a cornucopia. The apex, which will eventually be the lowest point of the dam, is snipped off, making the hole the size of the little finger. An inch and a half above this the edges of the cornucopia are cut out, making a perforation about one-half inch in size. In some cases a second row of perforations is cut about one inch higher up. The tampon is then introduced as follows:

"After the appendix has been removed and the cavity sponged out of all purulent material and blood, the operator carries the tampon into the cavity, the index finger being placed at its apex. The pads and retractors are still in place. The edges of the rubber dam are spread out and while the operator still keeps his finger on the apex, the tampon is filled with strips of packing."

It is best to overstuff the cavity so that when the drain is removed, as is done on the third or fourth day, we have a cavity the size of two fists, in the average adult, surrounded by omentum and loops of intestine. A tremendous amount of material drains from such a wound in the first forty-eight hours, while the temperature and pulse drop almost immediately and the improvement in the general condition of the patient seems miraculous.

Between January 1, 1914, and January 1, 1927, there were 1588 cases of acute appendicitis ranging in age from two to seventy-two treated on the First Division. Of these, 728 or 45.84 per cent were closed without drainage. These were the cases where there was no peritonitis or where there was only

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a moderate amount of turbid fluid without odor present Eight hundred and sixty or 54.16 per cent of the cases in the opinion of the operators required drainage It is worthy of note that over half the cases required drainage and that more than three-fourths of the total number did not enter the hospital until on or after the third day of their illness

The mortality for the whole group was 78 or 4.9 per cent The mortality for the 728 undrained cases was 4 or 0.55 per cent, showing the great advantage of early operation before the infection has spread to the surrounding tissues Of these four deaths, two, middle-aged patients, died of myocarditis, one died of pulmonary embolism, while the fourth died of paralytic ileus and peritonitis

As proof of a theory that the feminine sex seek medical advice earlier than the masculine, it was found that while 46 per cent of the total series were females, only 30 per cent of the drained cases were of this sex

An attempt to divide the drained cases into three groups was made Group No. 1 contains those cases where the appendix was completely necrotic or where it was ruptured in removing, or could not be satisfactorily inverted, also cases where oozing could be controlled only by packing, Group No. 2 consists of those cases where there was a spreading peritonitis with no limiting adhesions, Group No. 3 were the cases having a definite walled-in abscess separated from the general peritoneal cavity It is in the second or most severe group that Gibson-Mikulicz drain is, in our opinion, of greatest value

Because of variations in methods of classifying cases, no attempt is made to compare our series with cases reported from other clinics, but an attempt has been made to compare the Mikulicz drained cases with similar cases in our own clinic where other methods have been employed These other methods were largely employed in the first four or five years of the thirteen years under consideration because, as already stated, at the present time the Gibson-Mikulicz drain has almost entirely replaced all other forms of drainage

Of the 860 drained cases, 197 were drained with a folded rubber dam drain as follows

	<i>Cases</i>	<i>Deaths</i>	<i>Per cent</i>
Group No. 1	146	2	1.37
Group No. 2	18	4	22.22
Group No. 3	33	1	3.33

Cigarette drains were used in 179 cases

	<i>Cases</i>	<i>Deaths</i>	<i>Per cent</i>
Group No. 1	121	3	2.47
Group No. 2	19	6	31.57
Group No. 3	39	1	2.56

Rubber tube used in 37 cases

	<i>Cases</i>	<i>Deaths</i>	<i>Per cent</i>
Group No. 1	18	0	0.00
Group No. 2	10	2	20.00
Group No. 3	9	1	11.11

Gibson-Mikulicz used in 455 cases

	<i>Cases</i>	<i>Deaths</i>	<i>Per cent</i>
Group No 1	46	2	4.34
Group No 2	235	47	20.00
Group No 3	164	5	3.04

Iodoform gauze was used in one case and silkworm gut in one case

These tables show that in cases of peritonitis the Gibson-Mikulicz drain gives as low or lower mortality than any other form of drainage in the hands of the same operators. There are, in our opinion, several other distinct advantages to this type of drainage.

(1) Immediate lessening of toxicity as shown by lowered temperature and pulse has already been mentioned.

(2) Another important factor is that in removing this type of drainage, there is probably no pain. The old type gauze Mikulicz drain became densely adherent to surrounding structures and had to be pulled out by main force.

(3) In a majority of cases the wound is left entirely open, no sutures being introduced. This means that there is absolutely no secondary infiltration or infection of the abdominal wall and consequently no sloughing of tissues, particularly of the fascia.

(4) Formation of pocketing and secondary abscesses are almost non-existent.

(5) Doctor Gibson⁴ has called attention to the small number of fecal fistulae occurring in our series, which we credit largely to the wide-open type of drainage. He reported an incidence of 1.2 per cent as compared with 5 per cent reported from another clinic.

(6) Because of the protective action of the rubber dam, the adhesions formed, while firm enough for the immediate purpose of forming an abscess cavity, are not of the dense fibrous type, and rapidly disappear. In cases operated a year or more later for hernia, it is remarkable to find practically no adhesions in this region. Only one case in the series had to be reoperated for adhesions.

There have been some disadvantages called to our attention which we feel are far outweighed by the advantage of this drain.

(1) Increased length of stay in hospital. This averaged 23.4 days with Mikulicz drain and from 17.1 to 18.6 days with other types of drainage.

(2) Occurrence of hernia. Theoretically all these cases should develop hernia, but actually of 344 cases followed for one year or over only 14 per cent had hernia, while occurrence with other types of drainage varied from 5.5 to 6.8. Since abandoning the McBurney incision and using only the right rectus, this has dropped to 11.4 per cent. When such hernia occur they are extremely simple to repair, as there has been no loss of tissue. All that is needed is to differentiate the various layers and bring them together.

(3) Possibility of evisceration. This occurs very rarely and practically always in moribund cases where no attempt to form adhesions has taken place. There was no case in the series in which this occurrence was considered the cause of death.

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While for the purposes of this report, only cases of appendicitis were studied, still the Gibson-Mikulicz drain is applicable and useful in many other types of cases. It is of particular value in extensive retrocæcal neglected abscesses. Gall-bladders with severe infection of the surrounding tissues seem to be more easily and efficiently drained with this type than with other forms of drainage. Pelvic infections are easily drained through the vagina with this drain. Only recently I had a gunshot wound of the hepatic flexure of the colon. There was rather extensive damage to the wall, with considerable soiling of the surrounding area. By the use of two Mikulicz drains, I was able to pack off the whole region and keep the infection localized, thus preventing the usual sequelæ of a generalized peritonitis, and providing an extremely smooth convalescence.

I am extremely grateful to Dr. Charles L. Gibson for permission to publish these cases, all of which were operated by him and his assistants at The New York Hospital.

Tables showing mortality by decades, and occurrence of herniæ in relation to the type of incision are appended.

Mortality by Decades in Drained Cases

<i>Age</i>	<i>Cases</i>	<i>Deaths</i>	<i>Per cent</i>
2-10	115	11	9.56
11-20	265	16	6.03
21-30	208	13	6.25
31-40	118	8	6.77
41-50	80	9	11.25
51-60	60	13	21.66
61-70	13	4	30.76
71-80	1	0	0.00

Herniæ in Mikulicz Cases

Right rectus split	147 cases followed 19 herniæ 12.92 per cent
Right rectus retracted in	111 cases followed 10 herniæ 9.00 per cent
Right rectus retracted out	22 cases followed 3 herniæ 13.63 per cent
McBurney incision	61 cases followed 16 herniæ 26.22 per cent

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CONGENITAL ABSENCE OF THE GALL-BLADDER

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FROM THE SAMARITAN HOSPITAL

CONGENITAL anomalies of the liver and gall-bladder are rare. The presence of two livers in a human being is the rarest condition. Eshner gives Morgagni credit for reporting such a case, the gall-bladder was absent. I have been unable to find another such case in the literature. The next rarest anomaly is the absence of the gall-bladder and all ducts. This condition one would naturally suppose to be incompatible with life but such is not the case. Thirteen cases have been reported, one infant lived 216 days, another 150, another ninety, and still another seventy-seven, etc. Strangely enough only two of the thirteen lived less than twenty-four hours, the average duration of life for the thirteen being seventy days. The next rarest anomaly is absence of the gall-bladder, cystic and common ducts. Fourteen cases have been reported which with the case reported here makes a total of fifteen. This condition, of course, is compatible with normal existence, two of the patients having lived sixty years. The defect in each instance was not a contributing factor in the cause of death, one dying with pulmonary tuberculosis and the other with an infectious disease of unknown origin. Operation was not performed in either instance. The next rarest anomaly is the absence of the gall-bladder and cystic duct, thirty-one cases have been reported, the average age for this series being forty-eight years. Five of these were operated upon, three for a lesion involving the biliary tract—all were living when reported. Theodor, in 1908, reported the case of a male child, six weeks of age, on whom he did a hepatico-cholangio-enterostomy who died eight days after the anastomosis—the gall-bladder and cystic duct were absent. It is difficult to arrive at a correct estimate of the number of gall-bladders that have been absent without absence of the cystic duct because the surgeon or pathologist in most instances has not mentioned this structure. We have, therefore, only noted its presence when a definite statement regarding it was made. Four cases were reported, two in infants, ages three and eleven months, and two in adults, twenty-seven and twenty-eight years respectively. A true left-sided gall-bladder with viscus and common duct to the left of the falciform ligament is said by Schachner to have been reported thirteen times without transposition of other viscera. Double gall-bladder with double cystic ducts are infrequent.

The gall-bladder is said to possess a mesentery in about 5 per cent of instances. Anomalies in the position of the ducts and of the blood-vessels supplying the liver and gall-bladder are common, according to Behrend,

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occurring in the case of the ducts as frequently as 25 per cent and blood-vessels 51 per cent. Variations in the lobulation of the liver are not uncommon. A slight fossa may or may not be present and therefore there may be no line of demarcation of the quadrate lobe. Of the twenty-nine instances in which the presence or absence of fissure was noted in the findings, at operation or autopsy, it was absent in thirty-one or 72 per cent and present in eight.

Of the forty cases in which the gross appearance of the liver was noted, cirrhosis was diagnosed twenty-nine times, thirteen or 45 per cent were of the hypertrophic and sixteen or 55 per cent of the atrophic type. In adults over twenty years of age, the atrophic type was present in 70 per cent, in infants under one year, 70 per cent (seven out of ten) were of the hypertrophic type.

The gross appearance of the pancreas was mentioned in but 20 per cent of the cases, in one instance the head was missing, in three others the gland was atrophic, when mentioned in adults the pancreas in all instances was thickened, hard or indurated.

The size and position of the ducts were noted in twenty-four instances. This is important since dilatation by some is considered as evidence that the ducts are attempting to assume the function of the gall-bladder. The cystic duct was mentioned as being enlarged in two instances. Inasmuch as it was absent entirely in over 90 per cent of the cases this observation would not help us in arriving at any conclusion relative to an accessory function of this structure. The common duct was noted as being dilated in nine instances, normal in four and not mentioned in eleven. The hepatic ducts were dilated in 50 per cent of cases, normal in thirty, small in 8 per cent and not mentioned in 12 per cent. One would be justified in concluding that an attempt at dilatation of the hepatic ducts, and probably less frequently, the common, was observed in 50 per cent of the cases reported. While the average age of those who died with normal ducts was but thirty-six as compared with fifty-two years for those whose hepatic ducts were dilated, the first group died of various diseases which were

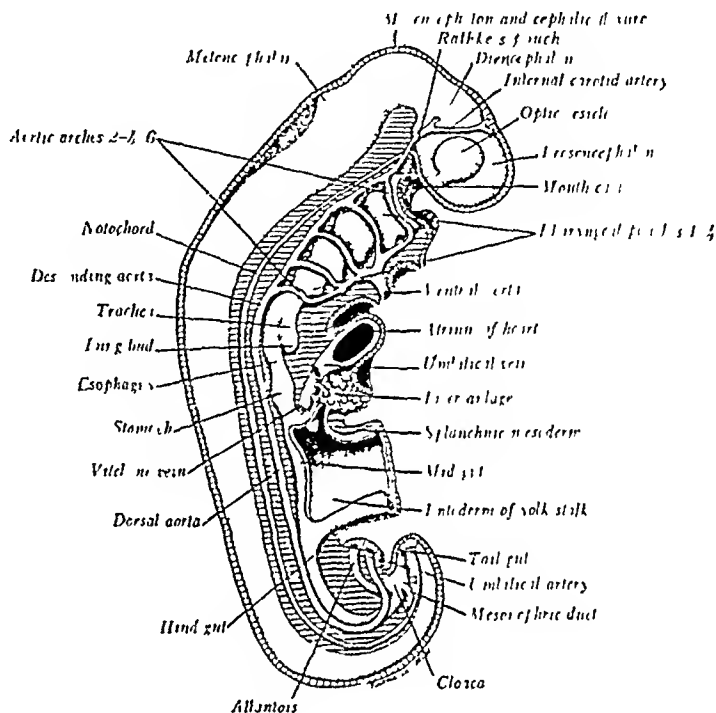


FIG. 1.--Shows the liveranlage as a median ventral outgrowth from the endoderm of the foregut, just cranial to the yolk stalk. Its thick walls enclose a cavity which is continuous with that of the gut. This hepatic diverticulum becomes embedded at once in a mass of splanchnic mesoderm, the septum transversum.

in no way associated with the pathology of the biliary system. The presence of atrophic or hypertrophic cirrhosis apparently had no bearing on the size of the ducts.

REPORT OF CASE—J B S, male, aged fifty years. Family and previous history—Mother died in confinement, father died age ninety years. One child living and well. Wife has had no miscarriages. No history of carcinoma or tuberculosis. Denies venereal

infection but states that physician discovered four plus blood Wassermann in May, 1925, and that he was treated by injections for five months. Several weeks following this, patient developed attacks of suffocation associated with mediastinal pain which radiated to the epigastrium. The pain was dull and aching in character radiating at times to the umbilicus. It was not associated with nausea or vomiting and he was not confined to bed.

Present illness, April 2, 1925, patient was seized with violent upper right abdominal

pain, cramp-like in character, the attacks lasting from five to ten minutes. He called his family physician who gave him a hypodermic. Since then he has had three similar attacks coming on at night, relieved by hypodermics but he was able to work the next day. With two of these attacks there was moderate jaundice, no other symptoms. The present attack began at 2 P.M., the pain was very severe but he obtained relief by taking soda bicarb which induced vomiting. The pain recurred eleven hours after the first attack and lasted for five hours. He was admitted to the American Stomach Hospital twenty-one hours after the onset of pain with a temperature of 98 and pulse of 102.

Physical Examination—

Patient is a well-developed, well-nourished male, adult. Intelligent, cooperative. No cyanosis or oedema present but slight evidence of jaundice. No cranial deformity. Eyes and ears negative. Pupils normal,

react to light and accommodation. Sclera has slight tint of jaundice. Teeth in poor condition. Tongue moist and coated. Chest—lungs negative. Heart not enlarged or displaced. Sounds normal. Pulse regular. Volume good. Abdomen—Scaphoid—definite tenderness and rigidity in upper right quadrant. Liver dullness diminished. Small amount of free fluid in peritoneal cavity. Extremities negative. Nervous and genito-urinary systems negative. Diagnosis, acute pancreatitis or perforated duodenal ulcer.

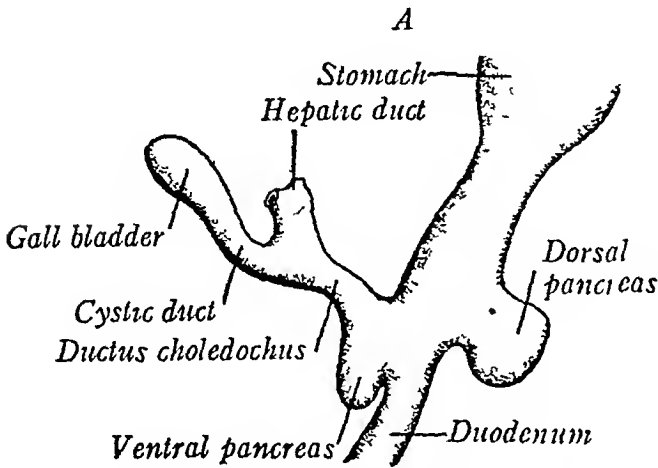


FIG 2—Reconstruction of the hepatic diverticulum (Embryo 7 to 8 mm) *Developmental Anatomy*, Arey, p 111

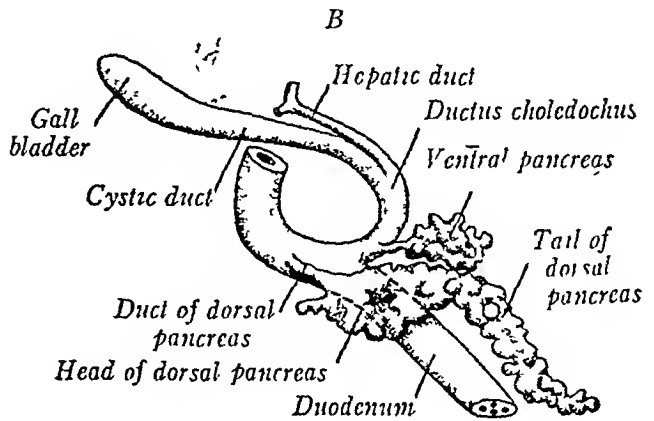


FIG 3—Further reconstruction of the hepatic diverticulum and pancreatic anlagen in human embryo. Arey, p 111

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Anæsthetic—Intraspinal—Stovaine 5¾ c g m in third lumbar interspace Cerebrospinal pressure diminished from 18 to 10 mm of mercury by withdrawal of 3 c c of spinal fluid anæsthesia to sixth rib—preliminary dose morphine sulphate gr 1/6, scopolamine gr 1/100 one-half hour before operation

Gross Findings—Liver ptosed, extended 15 cm below costal margin, normal in appearance, edge moderately sharp *The left lobe was entirely absent there was no gall-bladder or fissure present* The left border of the right lobe approached to within 3 cm of the midline of the abdomen To the left of the centre near the posterior inferior border of the liver were a few adhesions binding it to the posterior border of the tail of the pancreas The pancreas was exposed throughout its entire length The head was swollen and hemorrhagic Between the pancreas and the liver were large vessels, mostly veins as proved by aspiration Using a 2 c c glass syringe and a hypodermic needle, we were unable to obtain bile from smaller vessels which we considered hepatic ducts on either side of the largest veins There were grayish spots on the gastro-hepatic omentum which we took to be areas of fat necrosis although we were not positive The duodenum was of normal size and position, the serous coat was injected The stomach, small intestine and colon were negative The appendix was atrophied, palpated as a thin cord attached to the right pelvic brim The right kidney was slightly ptosed and of normal size The left kidney was normal The spleen was slightly enlarged

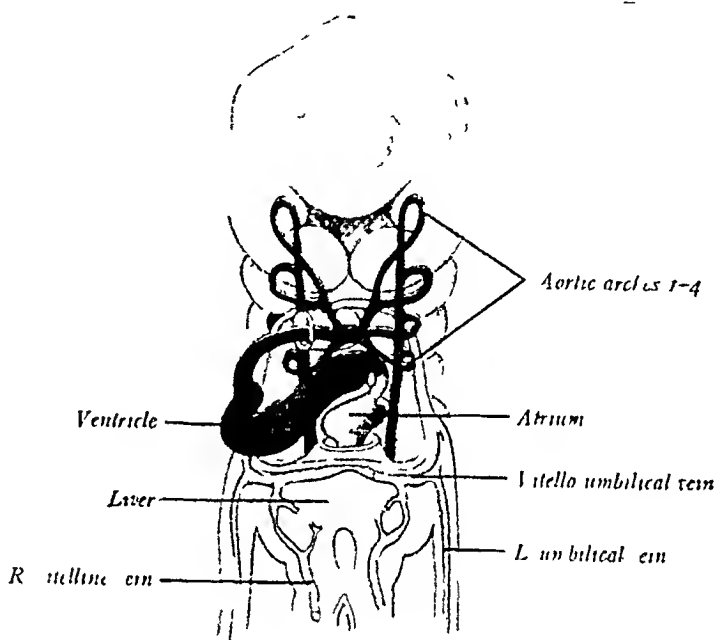


FIG 4—Ventral reconstruction of the blood vessels in a 32 mm human embryo *Developmental Anatomy, Arcy, p 187*

The adhesions were separated between the posterior inferior surface of the liver and pancreas and a soft rubber tube was placed at the head of the pancreas The wound was closed with No 2 chromicized catgut and interrupted silkworm gut and horse hair Convalescence was uneventful The drain was removed at the expiration of forty-eight hours, semi-solid food was given on the third day and he was discharged from the hospital on the fourteenth day He returned to his occupation as solicitor but complained of hunger pain and food ease He was admitted to the Samaritan Hospital where sodium tetraiodophenolphthalein was given both orally and intravenously without showing any evidence of a gall-bladder shadow, however a gastro-intestinal examination by Dr G C Bird, roentgenologist, was made—the report of which follows

X-ray Report—Examination before the administration of barium did not show anything diagnostic in gall-bladder or liver area In standing position greater curvature of the stomach was on a line with the umbilicus There were no filling defects in the stomach but the cap did not fill Plates made in the prone position do not show the duodenal cap Examination at the end of twenty-four hours still showed a barium retention in the stomach A sausage-shaped shadow is seen in the gall-bladder region which is outlined by flecks of barium QUERRY—has barium passed into the gall-bladder and is the gall-bladder located in the substance of the liver? (At operation it having been discovered that the gall-bladder was congenitally missing in its normal location)

The blood Wassermann was negative as was the blood chemistry. The family physician reports that following a modified Sippy treatment for duodenal ulcer his hunger pangs and food ease disappeared and he is at present symptom free.

Discussion—While there is no gall-bladder in certain families of birds, fish, some of the rodents, the horse, deer, camel, rhinoceros and elephant, according to Scammon there are only three forms consistently lacking a gall-bladder that are commonly available, for embryological study. These are the

lamprey (*Petromyzon*), the pigeon and the rat. He observed no common factors which would account for the absence of the gall-bladder in all of these examples. He states, however, "that in the rat it is possible that the rapid and early reduction in size of the yolk-stalk which leaves the foregut wall quite short antero-posteriorly may be a factor in inhibiting the development of the gall-bladder." While the occasional absence of the gall-bladder in man cannot be explained by these observations, it is interesting to note that of the three mentioned, one

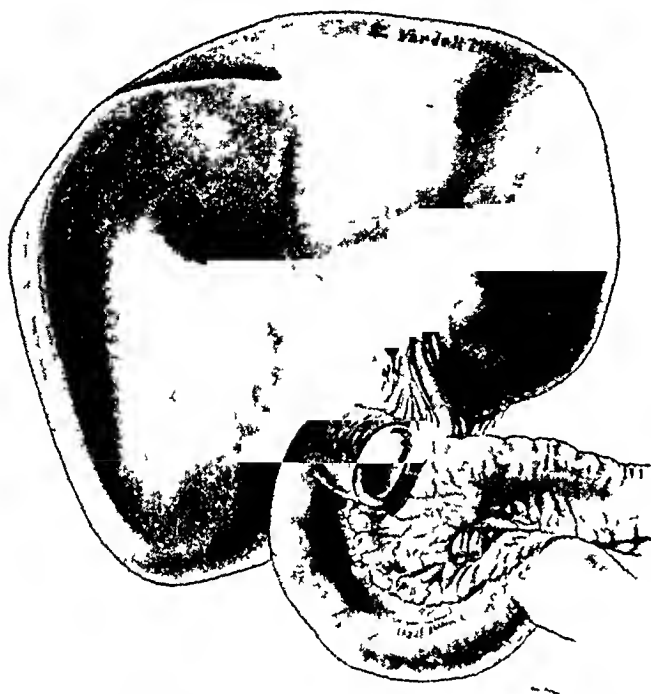


FIG 5.—Congenital absence of gall bladder. Left lobe of liver cystic and common ducts absent. Hepatic ducts apparently very small. Pancreas of normal size, head considerably larger than depicted above.

characteristic during the developmental stage is common to all, *i.e.*, atrophy of cells takes place. In the lamprey a complete biliary apparatus is formed in the larval stage, in the adult form there is a total degeneration of both gall-bladder and duct. In the pigeon the gall-bladder is developed in a perfectly normal way and later, in the majority of cases, at least, is completely lost. In the rat there is at most but a trace of cystic anlage in very early cases and this soon disappears.

In the human we have normally in the development of the liver a tremendous overgrowth of (liver) cells, the liver reaching the maximum size relative to the body at nine weeks. This is followed by a degeneration of liver substance, especially in the peripheral portion of the left lobe. While in the lower forms of animal life the atrophy of cells seems to be confined for the most part to the gall-bladder and ducts, in the human both liver and biliary apparatus are involved and in rarer instances the pancreas also is affected. Why there should be associated anomalies in the human can be readily understood when one studies the development of these organs in the embryo. Develop-

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mentally the liver represents a diverticulum from the ventral side of the entoderm shortly beyond the stomach (Fig 1) Two portions, a cephalic fairly solid portion and a caudal hollow one are early differentiated (Fig 2) The latter, the lumen of which is continuous with that of the duodenum represents the gall-bladder By a constricting process the ductus choledochus and hepatic ducts are formed and remain as the only connection which the cephalic or para hepatica retains with the duodenum The paracystica in the meantime dilates to form the gall-bladder and elongates to form the cystic duct

One or possibly two ventral evaginations from the entoderm are the anlagen also of the head of the pancreas and (Fig 3) appear at about the same time as the liver This would explain the associated defects in the pancreas, the absence of the head in Theodor's case and other associated defects If the primitive liver anlagen becomes the gall-bladder the glandular portion of the liver developing around it, one has no difficulty in explaining the intrahepatic gall-bladder Deaver estimates that in infants 2 per cent are totally intrahepatic Under ordinary circumstances the tension within the gall-bladder gradually forces it to the surface, the hepatic cells covering it, gradually disappearing The associated variations in lobulation of the liver can also be explained by the overgrowth and subsequent degeneration, of the liver cells as previously mentioned It may be as Arey states that any abnormality of the fetal vitelline and umbilical trunks may result in abnormalities in the biliary apparatus and pancreas inasmuch as the external lobes of the liver seem to be molded under their influence Figure 4 shows how the liver anlage lies between the vitelline veins and in close proximity to them laterally

The practical importance gained from the above is that whenever there is any difference in size, shape or contour of the liver, if not due to acquired disease, one should look for additional malformations or developmental anomalies in the biliary passages or in the pancreas

SUMMARY

- 1 A case of congenital absence of the gall-bladder, cystic and common duct together with an absence of the left lobe of the liver is reported
- 2 Conclusive evidence of a compensatory dilatation of ducts in the absence of a gall-bladder was wanting
- 3 Normal liver function is apparently maintained in a percentage of individuals with no gall-bladder and a diminished amount of liver tissue
- 4 On observing any variations from normal in size, shape or contour of the liver at operation or autopsy, a careful investigation should be made for developmental anomalies of the gall-bladder and pancreas

ABSTRACTS OF REPORTED CASES OF ABSENCE OF THE GALL-BLADDER

Reporter, Arnissat, year, 1831, age, 24, sex, F, jaundice, no, cause of death, abdominal chest disease, operated, no, liver—pathology, 11 m, liver—fissure, 11 m, gall-bladder, none, duct—cystic, yes, duct—common, yes, duct—hepatic, no, pancreas, spleen three times normal size, many supp nodules *Rev Med Franc et Etrangier*, vol 11, p 148, 1831

Reporter, Baker, year, 1835, age, n m, sex, n m, jaundice, n m, cause of death, supp process, operated, no, liver—pathology, n m, liver—fissure, present, gall-bladder, none, duct—cystic, n m, duct—common, n m, duct—hepatic, n m, pancreas, n m N A Archives of Medicine and Surgical Science, February, 1835, vol 1, No 5, p 307

Reporter, Bednar, year, 1850, age, six days, sex, M, jaundice, n m, cause of death, encephal, operated, no, liver—pathology, no kidney, gall-bladder, no, duct—cystic, n m, duct—common, n m, duct—hepatic, n m, pancreas, n m Ksh der neugeb u Sauglmze, vol iii, p 139, 1850

Reporter, Bergman, year, 1836, age, 60, sex, F, jaundice, n m, cause of death, insane, inf, coma, operated, no, liver—pathology, enlarged, liver—fissure, present, gall-bladder, replaced by small fibrous mass, duct—common, no, duct—hepatic, yes, pancreas, n m Hannoversche annalen fur die gesammte Heilkunde, B 1, p 552, 1836

Reporter, Blakeway, year, 1912, age, newly born, sex, n m, jaundice, n m, cause of death, n m, operated, no, liver—pathology, n m, liver—fissure, n m, gall-bladder, no, duct—cystic, n m, duct—common, n m, duct—hepatic, n m, pancreas, not developed cauda and corpus

Reporter, Boulet, year, 1772, age, n m, sex, n m, jaundice, n m, cause of death, n m, operated, n m, liver—pathology, n m, liver—fissure, n m, gall-bladder, n m, duct—cystic, n m, duct—common, n m, duct—hepatic, n m Comm de Rebus in Scientia naturale et medicine gestis, vol xviii, p 244, 1772, out of Pouppe de portia Historie des Maladies de S Donnique, vol ii

Reporter, Brande, year, 1816, age, three days, sex, n m, jaundice, n m, cause of death, n m, operated, no, liver—pathology, n m, liver—fissure, n m, gall-bladder, none, duct—cystic, yes, duct—common, yes, duct—hepatic, n m, pancreas, n m Mechels Arch G d Physiologie, 1816, p 249

Reporter, Bubenhofer, year, 1905, age, 66, sex, M, jaundice, none, cause of death, cardiac failure, operated, no, liver—pathology, cirrhotic and small, liver—fissure, none, gall-bladder, none, duct—cystic, no, duct—common, 9 mm lumen fill free, duct—hepatic, two very large, empty, collapsed Ueber emen Fall von Kougentalem Defest (Angensie der Gallenblase Anat Hefte Wiesb, 1905, vol xxvii, p 305

Reporter, Buddy, year, 1923, age, 28, sex, M, jaundice, yes, cause of death, accident fractured spine, int hem, operated, yes, died fourteen days, hem hepato lig, liver—pathology, evidence inf no scar formation, liver—fissure, barely indicated, gall-bladder, very rudimentary, duct—cystic, n m, duct—common, n m, duct—hepatic, yes, pancreas, case of checked development of the gall-bladder Uber gangeborne Gallenblase Verkumerung Arch F Klin Chir, Berl, 1923, vol cxvi, pp 45-47

Reporter, Buttner, year, 1769, age, misshapen fetus, jaundice, n m, cause of death, n m, operated, n m, gall-bladder, n m, duct—cystic, n m, duct—common, n m, duct—hepatic, n m, pancreas, n m Anatom Wahrnehmungen, Lpz, 1769, p 124

Reporter, Campbell Thompson, John Edin Med Jour, vol xxvii, p 728, pt ii

Reporter, Choloneley, year, 1820, age, five weeks, sex, n m, jaundice, yes, cause of death, convulsions, operated, no, liver—pathology, normal, liver—fissure, present, gall-bladder, cord, duct—cystic, directly into liver, pancreas, enlarged, indurated Med Trans of Coll of Phys of Lond, 1820, vol vi, p 50

Reporter, Canton, year, 1847, age, 65, sex, F, jaundice, n m, cause of death, n m, operated, no, liver—pathology, n m, liver—fissure, shallow groove, gall-bladder, no, duct—cystic, cystic artery absent, duct—common, two times normal size, duct—hepatic, dilated, pancreas, n m Lancet, 1847, vol xi, p 406

Reporter, Droste, year, 1853, age, 74, sex, F, jaundice, n m, cause of death, pulmonary disease, operated, n m, liver—pathology, atrophic, liver—fissure, no, gall-bladder, no, duct—cystic, n m, duct—common, n m, duct—hepatic, n m, pancreas, n m Deutsche Klinik, vol iii, p 305, 1853

Reporter, Eiben, year, 1910, age, 48, sex, M, jaundice, n m, cause of death, pneumonia, operated, n m, liver—pathology, normal, liver—fissure, no, gall-bladder, no,

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duct—cystic, no—union of two hepatic ducts into one passage, no dilation, pancreas, normal In Diss Giessen, 1910

Reporter, Elvert, year, 1780, age, adult, sex, M, jaundice, yes, cause of death, n m, operated, n m, liver—pathology, n m, liver—fissure, no, gall-bladder, no, duct—cystic, n m, duct—common, n m, duct—hepatic, n m, pancreas, n m Diss Praeside C F Jaeger Tubigen, 1780

Reporter, Emery L Bergman, year, 1701, age, n m, sex, n m, jaundice, n m, cause of death, n m, operated, no, liver—pathology, two lobes not separated, liver—fissure, no, gall-bladder, no, duct—cystic, numerous small ducts, pancreas, n m Mem de l'Acad des Sci, 1701

Reporter, Enopf, year, 1891, age, eight weeks, sex, n m, jaundice, yes, cause of death, inanition, operated, n m, liver—pathology, icteric enl, proliferations as in hereditary syph, liver—fissure, n m, gall-bladder, no, duct—cystic, no, duct—common, no, duct—hepatic, no, pancreas, normal Muench Med Wchnochr, vol xxxviii, p 283, 1891

Reporter, Enopf, age, six months, sex, n m, jaundice, yes, cause of death, Br catarrhal, operated, n m, liver—pathology, enlarged, lobes adherent, cells colorless liver—fissure, no, gall-bladder, no, only loose connective tissue, pancreas, hard and thick Muench Med Wchnochr, vol xxxviii, p 283, 1891

Reporter, Enopf, age, three months, sex, F, jaundice, n m, cause of death, catarrhal, operated, n m, liver—pathology, normal, liver—fissure, n m, gall-bladder, no, duct—cystic, two hepatic ducts uniting to D choledochus, pancreas, n m Muench Med Wchnochr, vol xxxviii, p 283, 1891

Reporter, Eshner, year, 1894, age, two months, sex, n m, jaundice, no, cause of death, broncho-pneu, operated, no, liver—pathology, normal, liver—fissure, no, gall-bladder, no, no ducts, pancreas, n m Medical News, 1894

Reporter, Ewers, year, 1914, age 45, sex, F, jaundice, n m, recovery, operated, exploratory appendectomy, liver—pathology, normal, liver—fissure, n m, gall-bladder, no, duct—cystic, no, duct—hepatic, in two hep, pancreas, head enlarged and hard In Diss Giessen, 1914

Reporter, Follet, year, 1828, age, n m, sex, M, jaundice, n m, cause of death, gastro-enteric, operated, n m, liver—pathology, n m, liver—fissure, no, gall-bladder, no, duct—cystic, n m, duct—common, n m, duct—hepatic, n m, pancreas, n m Rev Med Franc et etrangere, vol vi, p 139, 1828

Reporter, Fowler, year, 1917, age, 42, sex, F, jaundice, yes, recovery, operated, tube in common duct, liver—pathology, n m, liver—fissure, n m, gall-bladder, no, duct—cystic, no, duct—common, yes, duct—hepatic, yes, pancreas, hard and ind Schachner, ANNALS OF SURGERY, October, 1916

Reporter, Freund, year, 1876, age, three months sex, M, jaundice, yes, cause of death, marasmus, operated, n m, liver—pathology, cirrhosis, liver—fissure, a tube in fissure $1\frac{1}{2}$ c long, $1\frac{1}{2}$ c wide, gall-bladder, n m, duct—cystic, no, duct—common, no, duct—hepatic, no, pancreas, n m Jahrb f Kindersheilk, vol ix, p 178, 1876

Reporter, Gaultier, year, 1829, age, 60. sex, M, jaundice, yes, cause of death, pul tb, operated, no, liver—pathology, normal, liver—fissure, n m, gall-bladder, no, duct—cystic, directly into liver, pancreas, n m Jour de Medicine Nebdomadaire, July 11, 1829, tome iv, No 41, p 61

Reporter, Gay, R J, year, 1902, age, 27, sex, M jaundice, no, cause of death, endocarditis, operated, no, liver—pathology, n m, liver—fissure yes, gall-bladder, small intra-hepatic, duct—cystic, yes, ind, duct—common, yes, duct—hepatic, yes, accessory, pancreas, n m Tr Clin Path, 1902, vol cviii, p 113

Reporter, Golob, year, 1927, age, 59, sex, F jaundice, no, recovery operated, repair umbilical hernia, liver—pathology, n m, liver—fissure, n m, gall-bladder, no, duct—cystic, n m, duct—common, n m, duct—hepatic, n m, pancreas, n m J A M A, vol lxxvix, p 692, August, 1927

Reporter, Harle, E , year, 1856, age, 50 sex, F , gall-bladder, no, duct—cystic, no, duct—common, n m , duct—hepatic, n m , pancreas, n m Lancet, vol 1, p 304, 1856

Reporter, Heschl, year, 1865, age, four months, sex, n m , jaundice, yes, cause of death, died, age seven months, otorrhea, etc , operated, n m , liver—pathology, enl , liver—fissure, a narrow groove, gall-bladder, rudimentary, thick solid cord, duct—cystic, no dilatation, pancreas, n m Wien Med W , 1865, vol 15, p 493

Reporter, Hinder , year, 1909, age, 60, sex, M , jaundice, yes recovery, operated, acute abdomen, liver—pathology, n m , liver—fissure, no, gall-bladder, no, duct—cystic, no, duct—common, yes, duct—hepatic, yes, pancreas, hard Australia M Gaz , Sydney, 1909, vol 11, p 435 Outcome—recovery Previous history, qual dyspepsia

Reporter, Hobhouse , year, 1909, age, eight days, sex, F , jaundice, yes, cause of death, n m , operated, n m , liver—pathology, cirrhosis, 8 oz , liver—fissure, n m , gall-bladder, no, duct—cystic, no, bile secretion going on actively, duct—common, no, duct—hepatic, no Royal Soc Study Dis Child, Lond, 1904, vol v, p 177 Emaciated—weighed nine pounds—urine milky—contained no bile salts or pigment

Reporter, Hochsteeter , year, 1886, age, eight days, liver—pathology, right lobe large, left small, liver—fissure, 3/O-3P, gall-bladder, none, duct—cystic, ves, duct—hepatic, n m , pancreas, n m Arch F Anat Phvs, 1886, Anat Abteil, p 369

Reporters, Hoffman and Jackson, year, 1910, age, 65, sex, F , cause of death, pneumonia, operated, no, gall-bladder, no, duct—cystic, no, duct—common, dilated, duct—hepatic, yes, dilated N Y Med Jour , 1910, vol 101, p 338

Reporter, Home, Sir E , year, 1813, age, few months, jaundice, yes, cause of death, emanation, operated, no, gall-bladder, no, pancreas, pl tran Phil Trans Roy Soc London, 1813, cited by Canton

Reporter, (Eshner) Huber , year, 1749 age, 60, sex, F , cause of death, death po , operated, no, liver—fissure n m , gall-bladder, none, duct—cystic, abnormally large, villus usual sit , pancreas, biliary ducts enlarged Phila Trans Roy Soc London, 1744-1749, vol 1, R649, 1809

Reporter, Kehr , year, 1913, age, adult, sex, M , jaundice, n m , cause of death, n m , operated, n m , gall-bladder, none, duct—cystic, with stones, duct—hepatic, palpated Berlin Klin Wchnschr, 1913, vol 1, p 5111

Reporters, Kirmisson and Herbert , year, 1903, age, one month, cause of death, pulmonary, operated, no, liver—fissure, atrophic, gall-bladder, none, duct—cystic, none, duct—common, none, duct—hepatic, none Bull et mem de la Soc Anat de Par , 1903, vol 11, p 317

Reporter, Knox , year, 1744, age, 60, sex, F , jaundice, n m , cause of death, n m , operated, n m , liver—pathology, n m , liver—fissure, n m , gall-bladder, no, duct—cystic, n m , duct—common, n m , duct—hepatic, much dilated, pancreas, n m Phila Trans Roy Soc London, 1744, vol 1, p 649

Reporter, Lenain, B , year, 1853, age, 74, sex, F , cause of death, pulm dis , operated, no, gall-bladder, no, duct—cystic, no, duct—common, yes, duct—hepatic, no Deutsche Kliniks, vol v, p 305, 1853

Reporter, Lennander, K G , year, 1893, age, 40, sex, F , jaundice, after op , cause of death, escape of bile four days after op , operated, yes, died, duct—cystic, none, duct—common, yes, duct—hepatic, all very narrow Wen Klin Wchs Ojalry, p 710, 1893 Death due to bile leakage in peritoneal cavity—operator cut common duct

Reporter, Loreta , year, 1888, age, 40, sex, F , gall-bladder, none, duct—cystic, none, duct—common, n m , duct—hepatic, n m Riforma Med Anno, vol 14, pp 326-333, 1888

Reporter, Lintz , year, 1927, liver—pathology, very large, liver—fissure, no, gall-bladder, no, duct—cystic, none, duct—common, none, duct—hepatic, none, pancreas, blood-vessels normal Am J M Sc , vol 114, p 682, May, 1927

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Reporter, Littre, year, 1705, age, nine days, operated, no, liver—pathology, normal, gall-bladder, none, duct—cystic, none *Hist de l'acad des sciences*, 1705, p 53

Reporters, Eshner and Lynche, year, 1875, age, 11 months, jaundice, yes, operated, no, liver—pathology, large, liver—fissure, n m, gall-bladder, no, duct—cystic, large, duct—hepatic, small, pancreas, n m *Medical Press and Circular*, 1875, N S, vol xx, p 362

Reporter, Montault, year, 1829, sex, M, cause of death, carcinoma, pylorus, liver—pathology, atrophic, gall-bladder, no, duct—cystic, none *Bull de la Soc Nat d Paris* 4 amee, p 70, 1829

Reporter, Naegeli, year, 1921, age, 65, sex, F, operated, yes, liver—pathology, cirrhotic, liver—fissure, none, gall-bladder, none, duct—cystic, none *Virchows Arch of Path Anat Berl*, 1921, p 179

Reporter, Naegeli, year, 1921, age, 34, sex, F, jaundice, yes, operated, yes, drainage, liver—pathology, right lobe atrophic, gall-bladder, cord-like formation contained bile, duct—cystic, none, duct—common, dilated, duct—hepatic, gall-stone *Virchows Arch of Path Anat, Berl*, 1921, p 179

Reporter, Patterson, year, 1864, age, 35, sex, M, cause of death, asthma, operated, no, liver—pathology, four times normal size, gall-bladder, none, duct—cystic, no, duct—common, no, duct—hepatic, no, pancreas, n m *Medical Times and Gazette*, 1864, vol xi, p 476

Reporter, Pozzi, year, 1872, age, monster, born dead, gall-bladder, no, duct—cystic, no, duct—common, no, duct—hepatic, no, pancreas, n m *Bull et Mem de la Soc Anat de Par*, 1872, vol xlvii, p 90

Reporter, August Schachner, year, 1916, age, two, cause of death, syphilitic, liver—pathology, normal size, liver—fissure, no, gall-bladder, no, duct—cystic, n m, duct—common, n m, duct—hepatic, n m, pancreas, n m *ANNALS OF SURGERY*, 1916, vol lxiv, pp 419-433

Reporters, Eshner and Simpson, year, 1861, age, six weeks, cause of death, peritonitis, operated, no, liver—pathology, Spigelian and quadrate lobes absent, liver—fissure, no, gall-bladder, no, duct—cystic, no, duct—common, yes, duct—hepatic, no, pancreas, n m *Edinburgh Med Jour*, 1861, vol vi, Part II, p 1045

Reporter, Skorrin, year, 1902, age, seven weeks, sex, M, jaundice, n m, cause of death, broncho pneu, operated, no, liver—pathology, enlarged, gall-bladder, quill-like cord, duct—cystic, most of chole obliterated, pancreas, n m *In Diss Berlin*, 1902

Reporter, Sands, year, 1865, age, 20, sex M, jaundice, n m, cause of death, n m, operated, no, liver—pathology, liver small, quadrate lobe missing, liver—fissure, no, gall-bladder, no, duct—cystic, indefinite, pancreas, n m *N Y Med Jour*, June, 1865, vol i, p 222

Reporters, Raybault and Shachnam, year, 1882, sex, n m, jaundice, n m, cause of death, n m, operated, n m, liver—pathology, liver small, liver—fissure, yes, gall-bladder, no, duct—cystic, n m, duct—hepatic, normal, pancreas, n m *Reported by Ershner*

Reporter, Stone, year, 1908, age, 54, sex, F, jaundice, yes, recovery, operated, choledocotomy, liver—pathology, n m, liver—fissure, n m, gall-bladder, no, duct—cystic, no, duct—common, yes, duct—hepatic, yes, dilated, pancreas, n m *Amer Jour Med Science, Phila*, 1908, vol cxlv, p 889

Reporter, Stamm, year, 1916, age, 11 weeks, sex, M, jaundice, yes, cause of death, gastro-intestinal broncho-pneu, operated, autopsy, liver—pathology, enlarged, liver—fissure, thick, solid connective tissue band, gall-bladder, no, duct—cystic, no, duct—common, no, duct—hepatic, no, pancreas, soft, not enlarged, spleen enlarged *Felilen der grossen Gallen*

Reporters, Targioni and Tozzetti, year, 1756, age, n m, sex, n m, jaundice n m, cause of death, n m, operated, n m liver—pathology, no, liver—fissure, n m, gall-bladder, no, duct—cystic, no, duct—common, large, duct—hepatic, large, united with

panc duct, pancreas, n m Recueil Period d Observ de Med Par b Vandermonde, vol 1, p 280, Paris, 1756

Reporter, Theodor, year, 1908, age, six weeks, sex, M, jaundice, yes, death, eight days after operation, from wrong feeding, operated, hepato-cholangio-enterectomy at six weeks successful, liver—pathology, cirrhosis, liver—fissure, disproportionate, gall-bladder, no, duct—cystic, no, duct—common, yes, duct—hepatic, yes, pancreas, head of pancreas missing Arch of Kinderheilk, vol 111, p 358, 1908-1909

Reporter, Thomas, year, 1848, age, five months, sex, n m, jaundice, yes, cause of death, ascites amascara, operated, no, liver—pathology, 14 oz, no fat in liver bed cells, liver—fissure, no, gall-bladder, no, duct—cystic, no, duct—common, no, duct—hepatic, no, pancreas, n m Medical Times, July, 1848, vol 17, No 458, p 171

Reporter, Torrance, year, 1920, age, 38, sex, M, jaundice, no, cause of death, n m operated, yes, liver—pathology, n m, liver—fissure, n m, gall-bladder, no, duct—cystic, no, duct—common, normal, duct—hepatic, n m, pancreas, n m Trans Am Assn of Gyn and Obs, 1920, vol 111, p 386

Reporter, Trimble, year, 1850, age, 55, sex, F, jaundice, yes, cause of death, inf, liver—pathology, attached to pancreas, atrophic, liver—fissure, no, gall-bladder no, duct—cystic, no, duct—common, yes, duct—hepatic, no, pancreas, contained stone New Jersey Med Reports and Transactions, 1850, vol 1, p 303

Reporter, Vergne, year, 1826, age, 26, sex, M, jaundice, n m, cause of death, fell out of window, operated, no, liver—pathology, n m, liver—fissure, no, gall-bladder, no, duct—cystic, no, duct—common, n m, duct—hepatic, n m, pancreas, n m Recueil de memoir de med, Chirurg et pharn militaire, vol 1, p 406, 1826

Reporter, Weider, year, 1905, age, 15 days, sex, n m, jaundice, no, cause of death, cyanosis pat for ov, operated, no, liver—pathology, normal, liver—fissure, yes, gall-bladder, infers hepatic not covered, duct—cystic, n m, duct—common, n m, duct—hepatic, n m, pancreas, n m U of P Med Bull Phila, 1905, vol 111, p 213

Reporter, Weiderman, year, 1802, age, n m, sex, n m, jaundice, n m, cause of death, n m, operated, n m, liver—pathology, n m, liver—fissure, n m, gall-bladder no, duct—cystic, n m, duct—common, n m, duct—hepatic, n m, pancreas, n m Reils Arch F d Physiologic, 1802, p 144

Reporter, Wilson, year, n m, age, n m, sex, n m, jaundice, n m, cause of death, n m, operated, no, liver—pathology, n m, liver—fissure, yes, gall-bladder, no, duct—cystic, n m, duct—common, dilated, duct—hepatic, furrowed, pancreas, n m Cited by Canton

Reporter, Wuoesche, year, 1875, age, six days, sex M, cause of death, starvation, operated, n m, liver—pathology, normal, liver—fissure n m, gall-bladder, no, other anomalies, duct—cystic, greatly dilated, duct—hepatic, breadth of finger opened into duodenum, pancreas, H W S 2 cm Jahrb F Kinderheilk, vol 111, p 367, 1875

LYMPHOID HYPERPLASIA OF LACRYMAL AND SALIVARY GLANDS

MIKULICZ' DISEASE

BY JOSEPH F SMITH, M D

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AND

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OF CHICAGO, ILL

FROM THE SURGICAL SERVICE OF ST MARY'S HOSPITAL, WAUSAU WISCONSIN, AND THE HENRY BAIRD FAHNI
LABORATORY, ST LUKE'S HOSPITAL, CHICAGO, ILLINOIS

IN 1888,¹ Mikulicz described a symmetrical enlargement of the lacrymal and salivary glands, the glandular tissue of which had been almost entirely replaced by lymphoid tissue. This process, however, apparently was not a part of a generalized disease of lymphoid tissue. Since that time, there have been reported about 100 instances of similar symmetrical enlargement of these glands without alteration of the blood, without generalized enlargement of the lymph-nodes, without splenic enlargement, and without apparent systemic disease.

In view of the relatively infrequent occurrence of the so-called Mikulicz' disease, it seems quite worth-while to report another, especially since the changes in the tissues were not recognized, at first, as those of Mikulicz' disease and were confused with carcinoma.

CASE HISTORY—Mrs G L, age sixty-two years, a housewife, entered St Mary's Hospital, Wausau, Wisconsin, August 4, 1924, complaining of swellings in front of and below the ears and of periodic dryness of the mouth.

The trouble began one year before with a sudden pain in front of the right ear, which came on while eating, and was followed by the appearance of a nodule, the size of a walnut, below the right ear. This nodule decreased in size several times, but finally became progressively larger, especially during the four months before entering the hospital. In the meantime, swellings had appeared in front of and below the left ear.

She had been married for ten years with no pregnancies. She had had scarlet fever and diphtheria in early childhood. Some difficulty in swallowing remained after the latter disease. She always had been troubled with frequent attacks of tonsillitis.

Physical Examination—The patient is a rather obese, white woman with gray hair. She is mentally alert and physically active.

There is a flattened, dense, fairly well circumscribed swelling, about the size of a lemon, in front of the right ear. This mass extends caudad, forming a second portion below the right ear. There is a similar mass, the size of a pigeon-egg in the region of the left parotid gland, and a discrete, movable nodule in the left, anterior triangle of the neck.

Swallowing and tracheal movements are free. No enlarged lymph-nodes are found and the spleen is not felt. The heart is enlarged to the left but there is no definite murmur. The pupils, optic fundi, knee jerks, and superficial reflexes are normal. The temperature is 98.2 degrees F, the pulse rate 76 per minute, and the respiratory rate 18.

The blood has 98 per cent hæmoglobin, 4,780,000 erythrocytes per cubic mm, and 7,000 leukocytes. In skiagrams of the chest the shadow of the heart extends almost to the left border of the thorax, and both hilus-shadows are a little denser than normal. The Wassermann reaction (blood) is negative.

Operation—On August 5, 1924, a red, encapsulated mass was removed from the region of the left submaxillary gland (J F S). The operation was followed by X-ray therapy with recession of the masses. However, in the spring of 1925 the mass on the left side reappeared, but this time was not affected by exposure to X-rays. Nevertheless, the patient felt well and had gained nine pounds in weight.

November 9, 1925, the left parotid gland and the dense, adherent, associated mass of

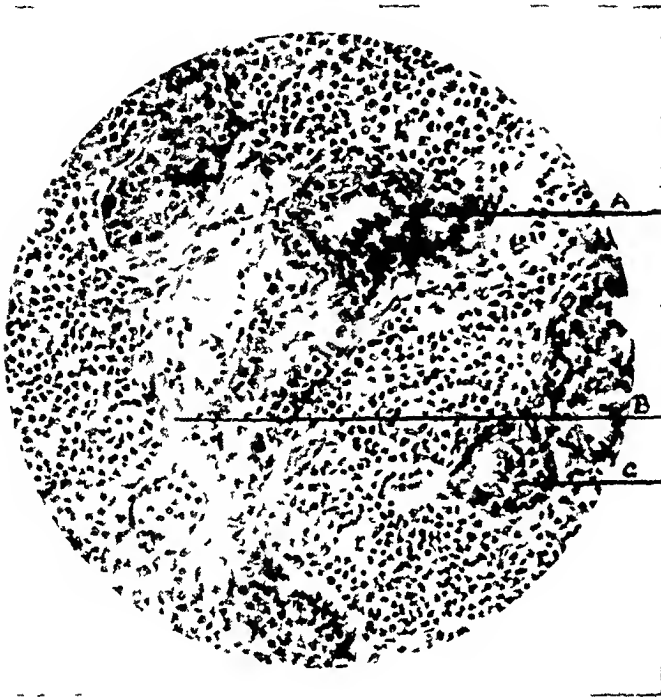


FIG 1.—Photomicrograph of section of the left submaxillary gland. A Duct-like epithelial structure. B Collagen. C Duct with its normal structure destroyed by ingrowth of lymphoid tissue (x275).

cent small lymphocytes, 19 per cent large lymphocytes, 4 per cent large mononuclears, and 2 per cent eosinophils.

Tissue, removed at the first operation, was considered to be a lymph gland with metastases of an epithelial growth, which in places had a duct-like appearance. Changes in the tissue, removed at a later operation, suggested to the same observer an embryonal carcinoma, possibly from the remains of a branchial cleft.

At the suggestion of Dr E R LeCount, who also examined the tissue and recognized it as the disease Mikulicz described, a more detailed study of the tissue was made by one of us (W S B).

Sections of the tissue, removed at the first operation, consist of lobules of rather closely packed cells, resembling lymphocytes, distributed in which are many, variously shaped, well demarcated islands of cells (Figs 1 and 2). Throughout the tissue, and especially about many of the cell-islands there is considerable connective tissue which in places is rich in fibroblasts and in others consists mainly of collagen (Fig 1, B). Here and there is distributed a moderate number of eosinophil leukocytes. Giant cells with large, clear nuclei are present but very scarce. There are some cells, somewhat larger than lymphocytes, with more basophilic cytoplasm and with the chromatin arranged as

tissue were removed (J F S). Later, nodules appeared below and in front of the right ear and the mass in front of the left ear reappeared. The glandular tissue on both sides was removed by the method of Adson, July 18, 1926 (J F S). The face remained symmetrical, except for a slight drooping of the upper lip, apparent only upon whistling.

May 9, 1927, the patient felt and appeared well. The erythrocyte count was 5,080,000 per cubic mm, the leukocyte count 7,500, and the hæmoglobin content 85 per cent. In smears of the blood there was no abnormal variation in the size, shape, or staining of the erythrocytes. Sixty-six per cent of the leukocytes were polymorphonuclear neutrophils, 7 per

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in plasma cells. In some sections, apparently cut from the periphery of the gland, there is considerable fat. Here are a few normal ducts with normal gland-acini.

The cell-islands, which are the outstanding structures in the sections, vary in shape from almost circular to branched forms (Figs 1 and 2). In some places their structure approximates that of normal ducts, that is, there is a definite lumen, lined by columnar cells with pale, oval nuclei (Fig 1,A). However, for the most part their structure is in varying degrees altered by the growth of the lymphocytes and connective tissue between the cells and into the lumens (Figs 1,C and 2). In many places the epithelial cells have undergone metaplasia, becoming squamous in type, as though from crowding by the lymphoid tissue (Fig 2,A). In some islands there is proliferation of the epithelial cells while in others there is little left, but masses of lymphoid tissue demarcated by connective tissue (Fig 2).

Three neighboring cell-islands, chosen at random, were followed through thirty-eight serial sections. A wax model, constructed to scale from outline drawings of these islands, demonstrates branching, like in an orderly duct-system (Fig 3) and therefore establishes beyond doubt that these structures are the remains of the duct-system of the gland, which was more resistant to the destructive process than the acini.

In a more detailed report of his patient in 1892² Mikulicz stated that the submaxillary glands were the size of a

child's fist. They had lobes and lobules, like normal glands, but surfaces, made by sectioning, were pale, red-yellow, speckled with more translucent places, instead of being normally finely granular and gray-red. The substance of the gland was lardaceous and was seemingly without blood-vessels. The tissue consisted of uniformly arranged round cells, in some places thickly packed and in others with a fine reticulum. Certain larger cells had mitotic figures. Imbedded in this mass of round cells were a few acini, considerably separated.

In the glands which Tietze³ examined no glandular tissue remained. Everywhere was lymphoid tissue with giant cells, atypical round cells, and many eosinophil leukocytes. He noted an over-growth of the capillary endothelium.

Stower⁴ found chronic inflammatory changes in the glands with round cell-infiltration, giant cells, occasional eosinophil leukocytes, a few epithelioid cells, and disappearance of the normal gland-structure.

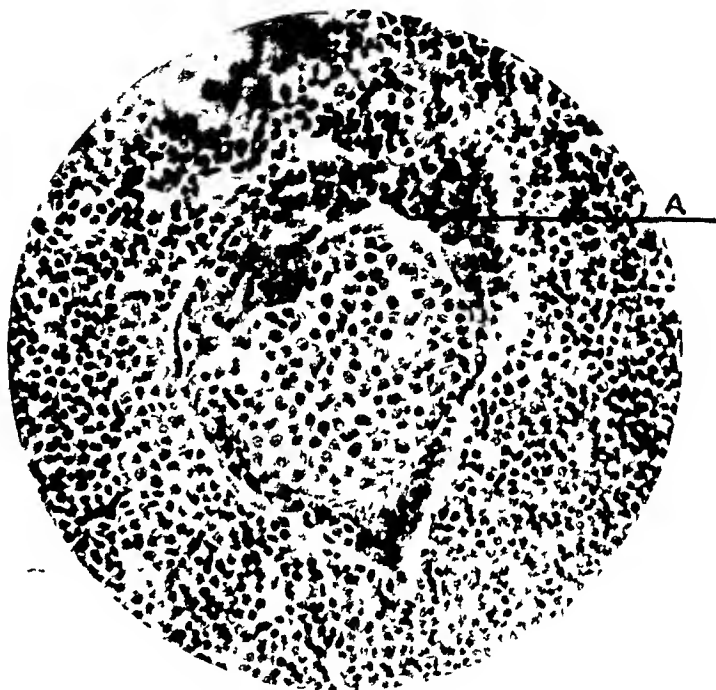


FIG 2 —Photomicrograph of section of left submaxillary gland with a duct markedly altered by the growth of lymphoid tissue. A Squamous epithelial cells ($\times 300$)

Bass⁵ noted an increase in the connective tissue, which was infiltrated with small round cells and plasma cells

Kummel⁶ described substitution of the glands by lymphoid tissue with eosinophil leukocytes and giant cells

The process was interpreted by Minelli⁷ as a marked proliferation of the lymph cells already in the gland with gradual replacement by connective tissue and with mechanical destruction of the original glandular tissue

The latter process, he thought, gave rise to cysts, foreign body giant cells, and eosinophil leukocytes. He described remains of ducts and acini which in his illustrations appear quite normal

Tissue, removed from the patient of De Wecker and Masselon,⁸ led to a pathologic diagnosis of epithelial tumor, although the only epithelial structures in the accompanying illustration were normal-appearing gland-acini

In short, the essential change in this disease has been described by all observers as a replacement of the normal glandular tissue, in whole or in part, by lymphoid tissue. For the most part, it is agreed that the glandular tissue, itself, plays entirely a passive

FIG 3—Wax model, constructed from outline drawings of thirty-eight serial sections, demonstrating duct-like branching of the epithelial masses

role, that its destruction is due to the tremendous proliferation of the lymphoid tissue. This lymphoid replacement-tissue has varied in the descriptions from a simple proliferation of lymphocytes to a lymphoid tissue with plasma cells, eosinophil leukocytes, and giant cells, and with considerable increase in the connective tissue

The description of the glands in this report is, therefore, essentially like those of other observers, except that structures, identified as ducts in varying stages of destruction are described and reproduced in photomicrographs. Consequently, this report is made not merely because Mikulicz' disease is relatively rare but mainly to describe these partly destroyed ducts, to the end that their presence need not be confusing

Mikulicz' disease may occur at any age, but usually in early adult or middle life. Of forty-one reports, collected by Howard,⁹ in which the data seemed sufficient to classify them with the so-called Mikulicz' disease, the oldest patient was seventy-seven years old, the youngest five and five-tenths, and the average age thirty-three. Twenty-six were men and fifteen were women. There was involvement of both the lacrymal and salivary glands in sixteen patients, with the first involvement of the lacrymal glands in nine, of the

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salivary glands in two, and with undetermined priority in five. The lacrymal glands were involved alone in eleven patients and the salivary glands alone in fourteen. Both increase and decrease in glandular secretion were not infrequent symptoms.

Mikulicz, in his report of 1892, ventured a suggestion as to the origin of the peculiar disease. He thought that it was neither neoplastic nor related to leukæmia, because of the localization of the disease to the region of the face, the normal blood-formula, the lack of generalized lymphatic enlargement, and because, once the gland was wholly extirpated, it did not recur. He was aware that Heidenhain had found lymphoid tissue in the normal glands. Bearing in mind the remarkable and prompt response of lymphoid tissue to infecting organisms, he suggested that the disease was an infectious or parasitic one, the glandular tissue being destroyed by the excessive growth of the lymphoid tissue of the glands. He conceived of the infection beginning in the lacrymal glands, probably from the conjunctival sac, and then secondarily involving the salivary glands by way of the tear-duct, pharynx, and mouth.

Brunn¹⁰ noted that symmetrical enlargements of the lacrymal and salivary glands involved the lacrymal glands alone, or the salivary glands alone, as well as involving both sets of glands. He found that these enlargements had been reported as unaccompanied by changes in the lymph-nodes, spleen, and blood, and that they had also been reported with enlargement of the lymph-nodes and spleen¹¹ and even with a leukæmic blood-formula¹². Therefore, he concluded that the condition, described by Mikulicz, was a symptom-complex, rather than a disease-entity, and that it bore a close relationship to pseudoleukæmia and leukæmia. Many later writers have agreed with Brunn, believing that there is no definite line of division between the uncomplicated salivary and lacrymal enlargements and those occurring with pseudoleukæmia and leukæmia, that one group merges into the other, and that they probably have a common cause.

On the other hand, symmetrical enlargement of these glands has also been reported as coexistent with tuberculosis, syphilis, erythema multiforme, and epidemic encephalitis, and even has been connected with deranged function of the glands of internal secretion. However, no conclusive evidence, such as the finding of tubercle bacilli, spirochæta pallida, or other organisms in the tissue, has been presented, except by Krailsheimer,¹³ who reported the discovery of numerous tubercle bacilli in the submaxillary gland, as well as tubercle-like nodules in the iris.

And furthermore, Mikulicz' disease has been classified by Ziegler¹⁴ as an atypical form of Hodgkin's disease, similar to that form which involves the gastro-intestinal tract.

Inasmuch as the origin of lymphatic leukæmia, pseudoleukæmia, and Hodgkin's disease is entirely unknown, the attempt to connect Mikulicz' disease with them does not serve to clarify our knowledge of the nature of the disease. Then too, if there is such a close connection between all symmetrical enlargements of the lacrymal and salivary glands and these little-

understood diseases, it seems strange that such a large group with symmetrical glandular enlargement has not developed apparent signs of leukæmia, pseudoleukæmia, or Hodgkin's disease. The disease had existed for three years in Ranzi's¹⁵ patient without change in the lymph glands or in the blood, for five years in Snell's¹⁶ and in Berlin's¹⁷ patients, for eight years in Kummel's¹⁸ patient, and for twelve years in Tietze's¹⁹. Zondeck²⁰ later stated that the patient of Tietze's report had not developed change in the blood after another ten years, although the involved glands had become larger. There is no report of any patient, whose disease began as the uncomplicated one of Mikulicz, who died of that disease or as a direct result of it, except for the patient of Marcuse²¹. However, not long after the disease was noticed in this patient, the lymph glands were found to be enlarged, especially the mediastinal group, and death occurred eighteen months after the onset of the disease.

Kummel, De Wecker and Masselon, Berlin, Hahnle,²² and Rollet²³ have noted, like Mikulicz, that there is no recurrence if the gland of Mikulicz' disease is completely removed. This is not the rule with the glandular involvements of leukæmia or Hodgkin's disease.

In view of these discrepancies, the ideas of Munck²⁴ seem, indeed, rational. He has called attention to the work of Chiewitz,²⁵ which indicates that the lymphoid tissue, found in the normal salivary or lacrymal glands, is anatomically and embryologically a part of the lymphatic system. Therefore, it is to be expected that this tissue would be subject to the diseases to which lymphoid tissue, elsewhere, is subject. Hence, it may react to various infections, including tuberculosis and syphilis, and may participate in such diseases as leukæmia, pseudoleukæmia, and Hodgkin's disease. While symmetrical enlargement of the lacrymal and salivary glands may be incidental to such diseases as leukæmia or Hodgkin's disease, or may be due to tuberculosis or syphilis, nevertheless, the original suggestion of Mikulicz may be true, that there is, indeed, a group in which the glandular enlargement is due to an infection, the organisms gaining entrance through the ducts of the glands by way of the conjunctival sac or buccal cavity. The occurrence of conjunctival, nasal, pharyngeal, or tonsillar infection, preceding the onset of the disease, has been reported by several observers²⁶ and may not be without significance.

If the term, Mikulicz' disease, be made to include all chronic, symmetrical enlargements of the lacrymal and salivary glands, it is evident that it cannot imply a disease-entity. Nevertheless, there seems to be a definite group of patients, like the patient of Mikulicz' report, whose disease has a long course without effect upon the general health or life of the patient, and hence, with a wholly different prognosis than that of leukæmia or Hodgkin's disease.

Summary—Structures in the salivary glands of a patient with Mikulicz' disease are identified as ducts in various stages of destruction, are described, and are reproduced in photomicrographs.

Mikulicz' disease is essentially a disease of the lymphoid tissue of the lacrymal and salivary glands with secondary destruction of the parenchyma. It is probable that this lymphoid tissue, for the most part solitary nodes in

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and about the walls of the ducts, undergoes or is subject to diseases quite like those of lymphoid tissue elsewhere in the body. A separate classification of these diseases seems unnecessary.

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THE SURGICAL PATHOLOGY OF EPIDIDYMITIS

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ALTHOUGH epididymitis is predominantly of gonococcus etiology other bacteria may produce lesions clinically indistinguishable either from those of gonorrhœal origin or from those due to the tubercle bacillus. We found in a recent study of 3606 cases of epididymitis admitted to the Urological Service of Bellevue Hospital that while 3000 of this number resulted from Neisserian infection, the remainder were etiologically divided between those of tuberculosis (280) and those commonly designated as "non-specific" in origin (326). We are not concerned here with the tuberculous variety. "Non-specific" we more properly designate as non-gonorrhœal non-tuberculous since staphylococci, streptococci, colon bacilli, Friedlander bacilli and more rarely micrococci catarrhalis may be etiologically identified with the epididymitis, either individually or in combination.

Demonstration of the gonococcus in the discharge of an associated urethritis confirms the diagnosis of gonorrhœal epididymitis. Often no discharge is present which may mean (1) there is a latent gonococcus infection of the posterior urethra and adnexa (prostate and seminal vesicles) or (2) the epididymitis is non-gonorrhœal in origin. Urethral discharge may, however, contain some of the pyogenic bacteria above mentioned and no gonococci. This finding usually indicates the etiology of the lesion.

The diagnosis having been made, the patient is at once put to bed, given a cathartic, and the adhesive plaster scrotal suspensory dressing described elsewhere is applied.¹ Complete immobilization and high elevation of the scrotal contents is attained by this dressing, its equal cannot be purchased in shops. As a rule an ice cap is applied to the inflamed parts although in some cases greater relief is afforded by heat. Pain will be relieved at once in many and within twelve hours in two-thirds of these cases.¹ Those not able to sleep the second night after institution of this treatment are operated upon. For some time a persistent elevation of the temperature was our operative criterion, but we have found the persistence of pain is a more reliable surgical guide. One in fifteen of the gonorrhœal and one in four of the non-gonorrhœal non-tuberculous cases required operation. Epididymotomy is the procedure of choice, although occasionally epididymectomy and more rarely orchidectomy must be performed.

Surgical treatment of epididymitis by puncture was first employed by Velpeau.² Plunging a needle through the skin, multiple punctures were made in the underlying indurated mass. Immediate relief was obtained in most cases, the surgical complications of hemorrhage and infection are not

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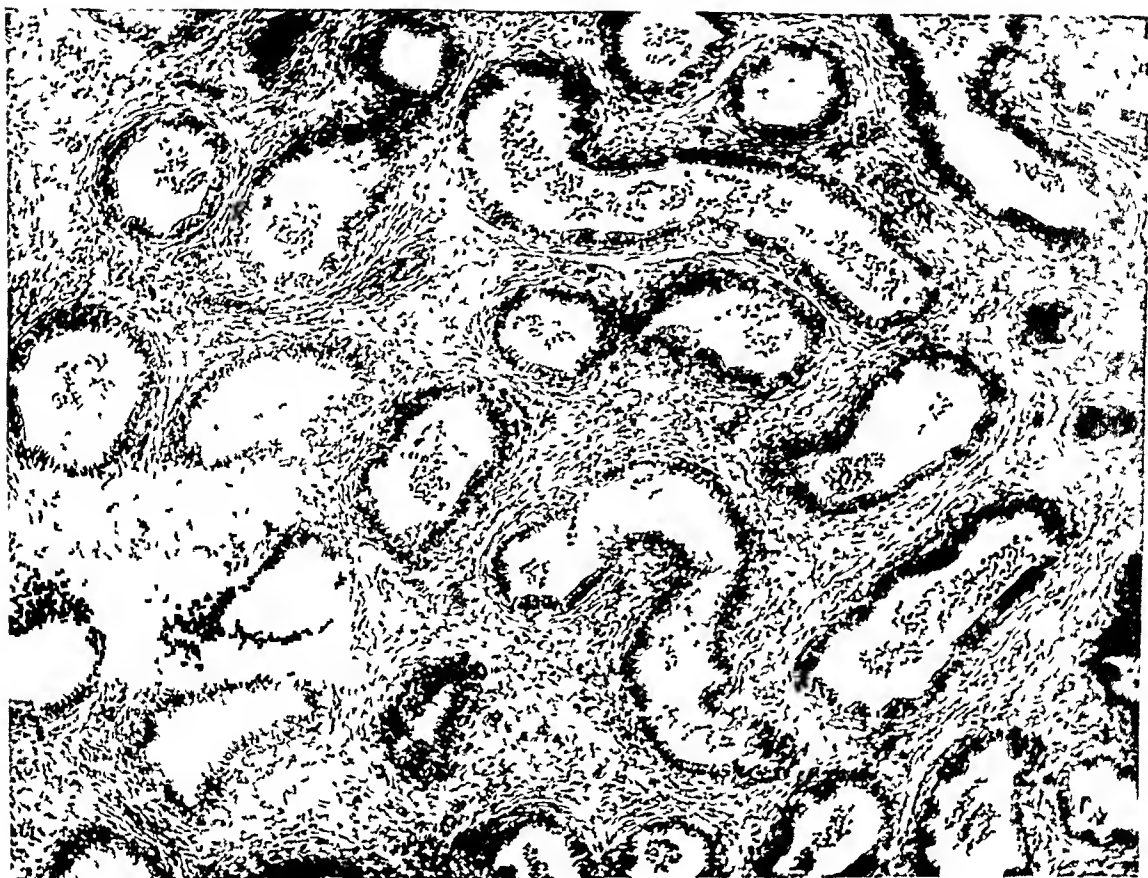


FIG 1 —Beginning intratubular leucocytic exudation. At this stage there is but moderate cloudy swelling without loss of normal structures. Exudate is chiefly polymorphonuclear. Early interstitial infiltration is noteworthy.

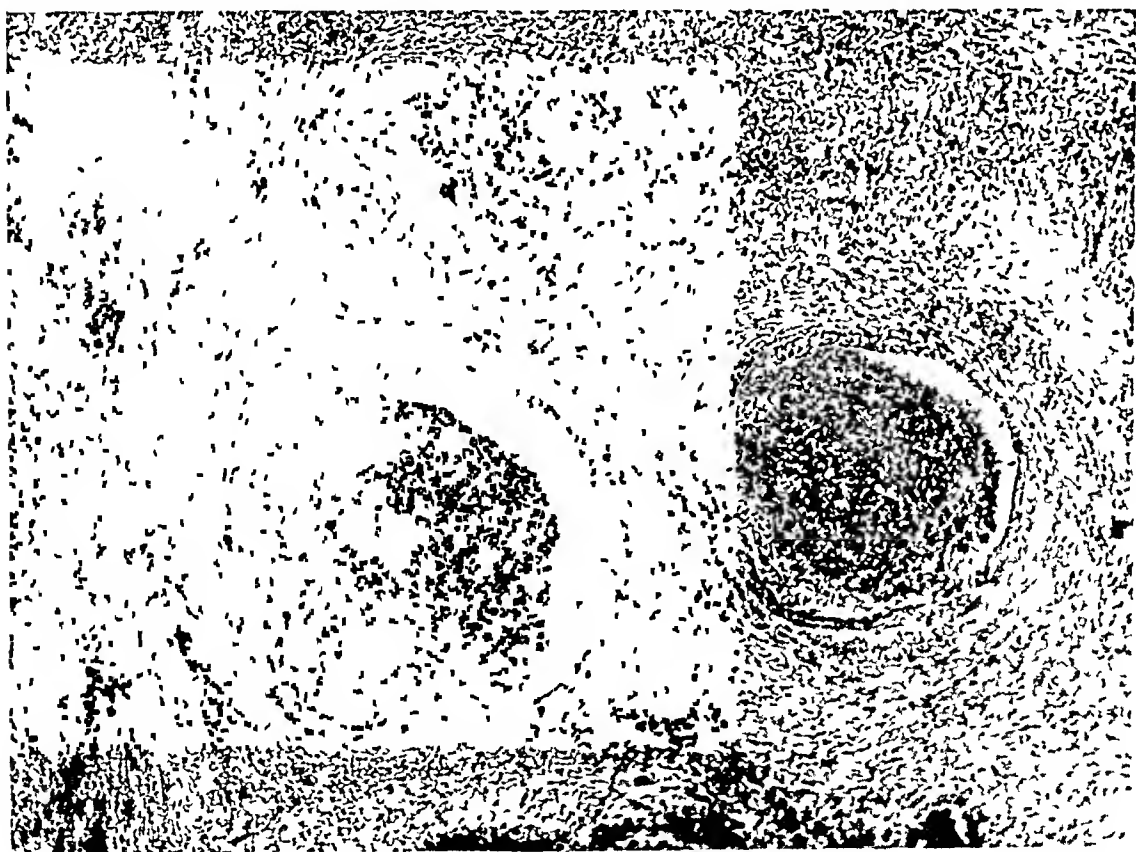


FIG 2 —Tubular filling with rupture of basement membranes and extension into interstitial tissue. Intensification of leucocytic stroma infiltration.

recorded Velpeau's work was subsequently warmly endorsed by de Cassis and others. Open epididymotomy, however, was first performed by Pirogoff³ in 1852. Twelve years later and unaware of Pirogoff's work, Smith⁴ recorded

TABLE I

Age	Gc	Non Gc	Total
19 and under	8	1	9
20-29	159	25	184
30-39	33	25	58
40-49	5	17	22
50-59	2	8	10
60 and over	1	1	2
Not recorded	1	2	3
			<hr/> 288

TABLE II

Side Involved	Gc	Non Gc	Total
Right	104	38	142
Left	79	35	114
Bilateral	26	6	32
			<hr/> 288

twenty cases of acute epididymitis in which the agonizing symptoms were at once relieved by exposure of the epididymis and multiple incisions into its substance with a sharp knife, "being careful not to incise the testicular substance." Since Smith's paper several surgeons have reported numerous epididymotomies, but it remained for Hagner⁵ (1906) to demonstrate a safe and simple technic which may be unhesitatingly and universally employed. The Hagner method of epididymotomy is the routine procedure in the Bellevue Hospital Urological Clinic. Epididymectomy is performed for (1) gross destruction of the epididymis and (2) recurrence of epididymitis after epididymotomy or (3) in some cases after repeated attacks without operation. Diffusely cystic and some otherwise grossly diseased epididymes have at times been removed.

Of 3326 cases of non-tuberculous epididymitis studied by us, 209 of the gonorrhœal and seventy-nine of the non-gonorrhœal cases were operated upon. Epididymotomy was performed a total of 200 times. Epididymectomy primary or secondary was the procedure in seventy-four, and orchidectomy for abscess in thirty-five cases (Table III), a total of 309 operative procedures on 288 patients. Sometimes the epididymis and testicle were removed en masse. From these operations seventy-six surgical specimens have been available for study and constitute the basis for our discussion of the histopathology.

All chronically inflamed and most subacutely inflamed epididymes may be removed under local anæsthesia (fifty-eight times). Manipulation of the

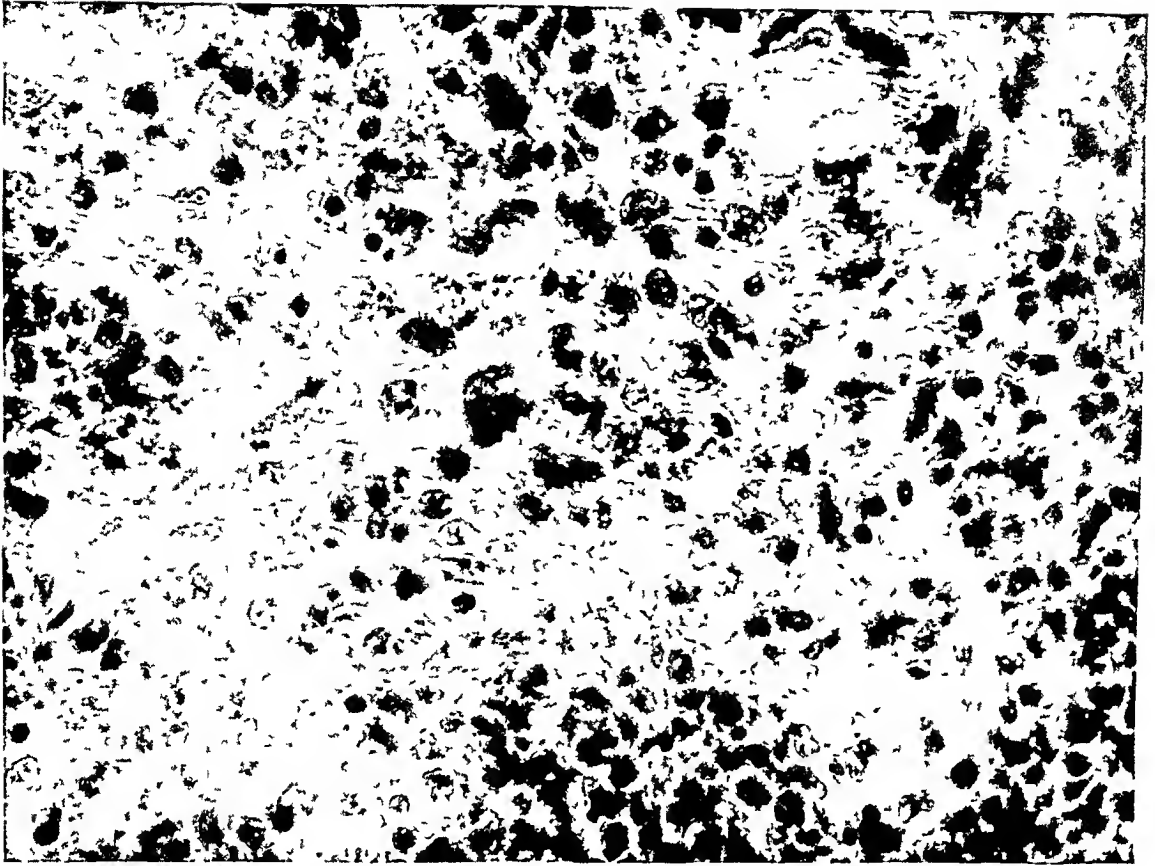


FIG 3 —Character of early cellular exudate in wall of a tubule. Of particular interest are the numerous plasma cells and large mononuclears

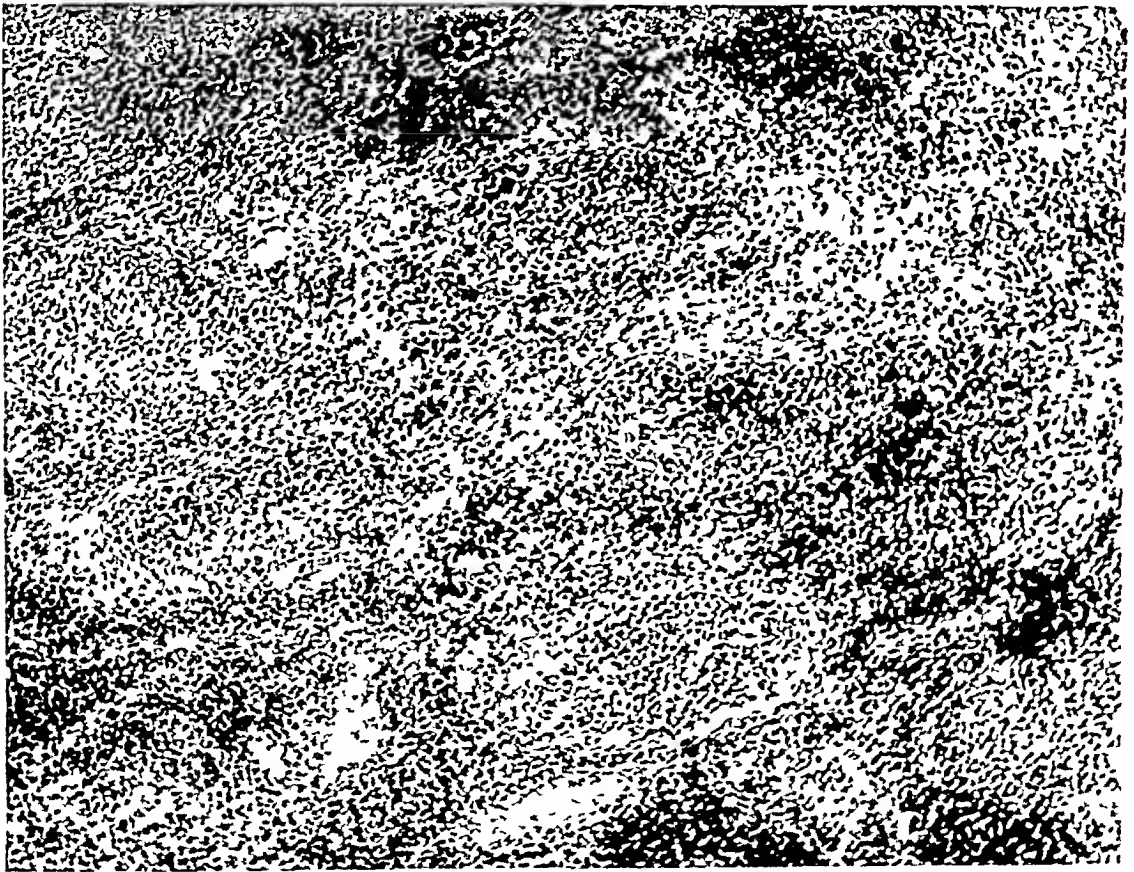


FIG 4 —Later stage of Fig. 2. The location of former tubules is suggested by lighter areas in suppurative mass

TABLE III

Type of Operation	Gc	Non Gc	Total
Epididymotomy	178	22	200
Epididymectomy			
Primary	24	45	69
Secondary to Epididymotomy	3	2	5
Orchidectomy			
Primary	5	16	21
After			
Epididymotomy	5	7	12
Epididymectomy	1	1	2

acutely involved organ is often painful even after novocain infiltration, and in this group the administration of a general anæsthesia has been our procedure of choice (170 times) In seven cases spinal anæsthesia was used with entire success and in the hands of one skilled in its use, is the ideal anæsthesia

The scrotum about to be incised is tense and shiny if the process is acute Certain areas with underlying gross abscess may be glazen in appearance Scrotal œdema adds greatly to the size of the inflammatory mass If the lesion is subacute or chronic, integumentary changes may be absent or those of mild injection and œdema

Usually the tunica vaginalis is thickened, indurated and when incised releases a variable quantity of hydrocele fluid, the formation of which results from inflammatory irritation of the serous membrane Exudation was recorded as present in 101 of the operated cases Clear or cloudy fluid was noted to be present in sixty-eight, the quantity varying from 5 cc to four ounces When the process is acute, fibrin is usually found We observed it in amounts of one dram to three ounces twelve times Occasionally organized fibrin will add great palpable solidity to the mass, and was found in four instances Serosanguineous fluid is occasionally encountered, as is free pus (Table IV) If the lesion has been present for some days or if there

TABLE IV

Hydrocele Present	Gc +	Gc —	Total
Fluid 1 dram to 8 ounces	53	15	68
Fibrin 1 dram to 3 ounces	8	4	12
Fibrin (organized) ½ oz to 1½ oz	4		4
Serosanguineous fluid	4	2	6
Free pus in tunica vaginalis	6	5	11
			101

has been antecedent inflammation, adhesions may firmly bind the tunica vaginalis to the epididymis and testicle or may tenaciously unite the testicle and epididymis in a solid mass Furthermore, if the epididymitis is a recurrent

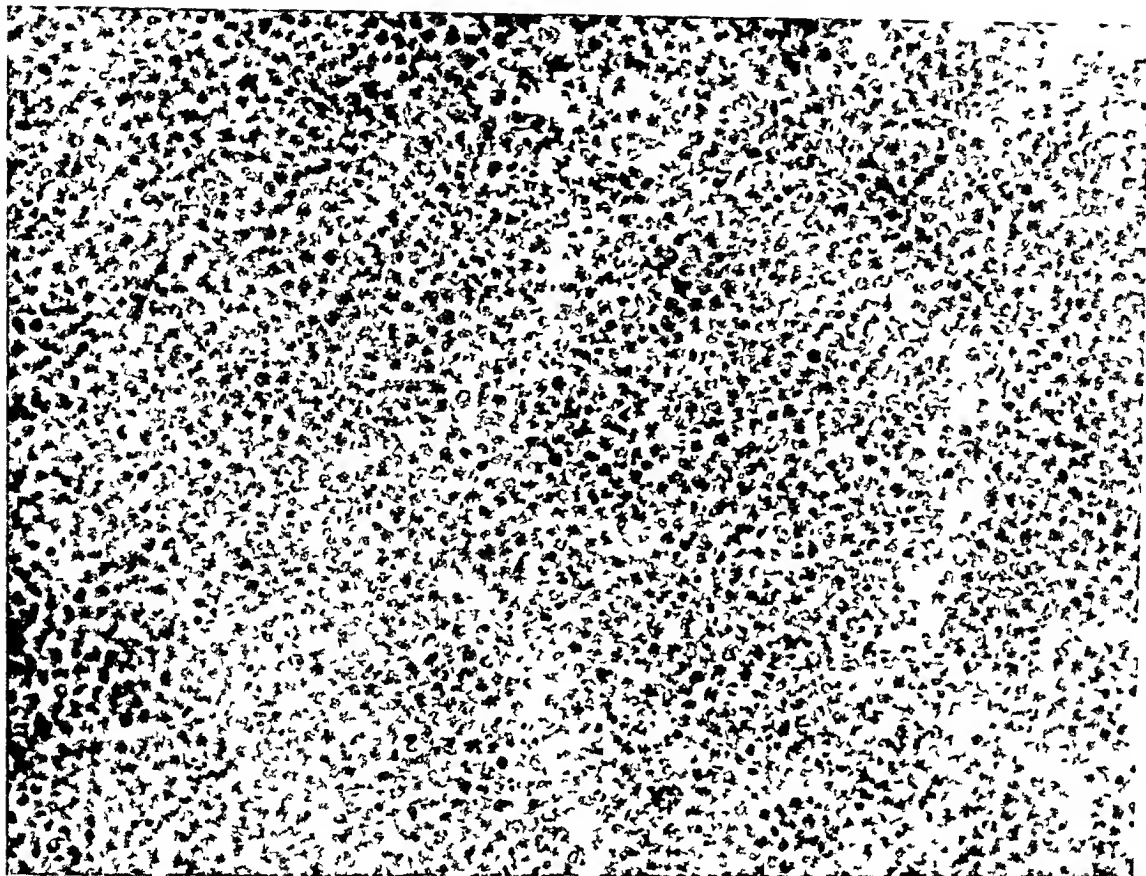


FIG 5—Massive necrosis of epididymis No landmarks A later stage of Fig 4

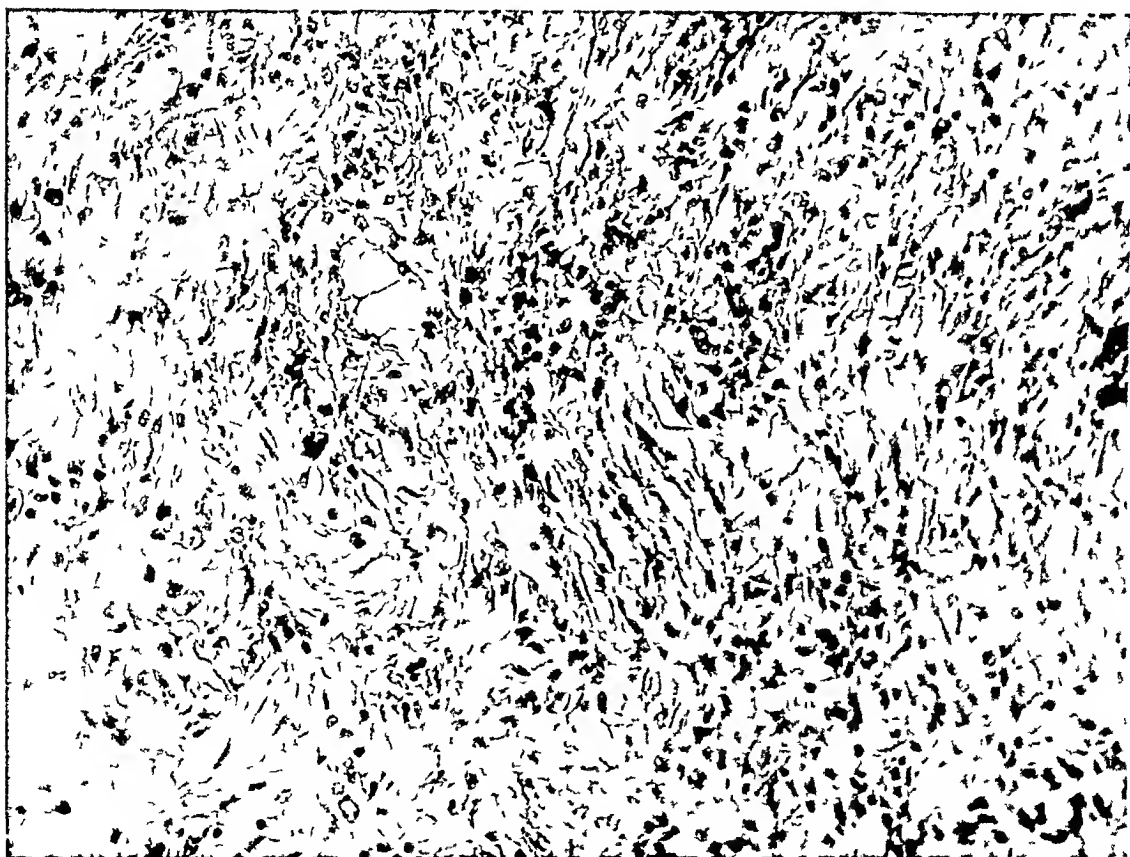


FIG 6—Edematous infiltration of stroma of epididymis with vacuolization

attack cystic degeneration of the organ is frequently observed. While probably of greater incidence cystic changes were noted five times in this series. Inflammation of the tunica vaginalis is proportional to the severity of the attack. The membrane may be either velvety-red or pallid. Coexisting infection of the tunica albuginea may be observed, but the testicle is not involved except secondarily by (1) extension of an epididymis abscess or (2) by thrombosis of the lower spermatic cord with trophic gangrenous orchitis.

The anatomical progression of the infection from the posterior urethra, prostate, and seminal vesicles down the vas deferens explains the greater incidence and increased severity of globus minor involvement. That transmission of infection is unquestionably by the vas and its mural lymphatics has been clinically demonstrated by vasectomy. Prior to 1925, 30 per cent of our prostatitis at Bellevue developed acute epididymitis at some stage of their hospitalization, usually post-operatively. Two years ago routine vasectomy (ligation with resection of 1 cm. of vas) was instituted, and since then this type of epididymitis has occurred but twice. Metastatic pyogenic blood-borne infection of the epididymis has been observed but is rare. We have seen it associated with influenza, pneumonia, and acute tonsillitis each in one case.

Gross examination and incision of the exposed epididymis clearly indicates that the lesion is nearly always most acute in the globus minor. It may be limited to this part, but extension to the globus major or head usually occurs with the formation of numerous punctate abscesses. Frequently by coalescence of these abscesses the entire organ is converted into a suppurating mass and by extension, secondary destruction of the testicle may ensue (Table V).

TABLE V
Gross Surgical Pathology

	Abscess			Inflammation					
				Acute			Chronic		
	GC +	GC -	Total	GC +	GC -	Total	GC +	GC -	Total
Epididymis									
Head	26	5	31	21	1	22			
Body	12	4	16	1	1	2			
Tail	41	12	53	8	11	19		1	1
Universal	23	8	31	67	27	94		2	2
Cord		1							
Vas	3	1	4	2		2			
Testicle	4	8	12						
Present (location									
Not recorded)	90			105					

It is to be noted, moreover, that gross suppuration requiring surgical liberation is observed four times more frequently in the non-gonorrhœal than in the gonorrhœal cases and the incidence of secondary suppurative orchitis is

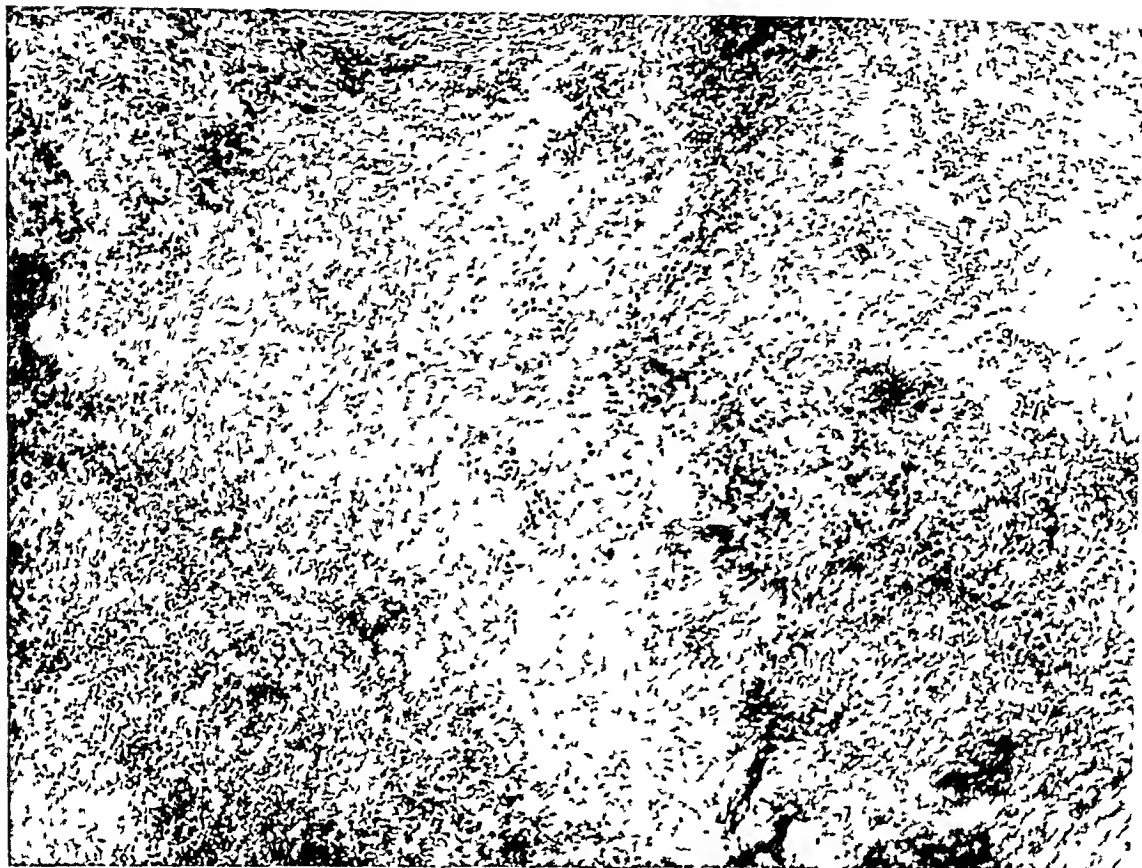


FIG 7—Hyalin degeneration with vacuolization Generalized leucocytic infiltration

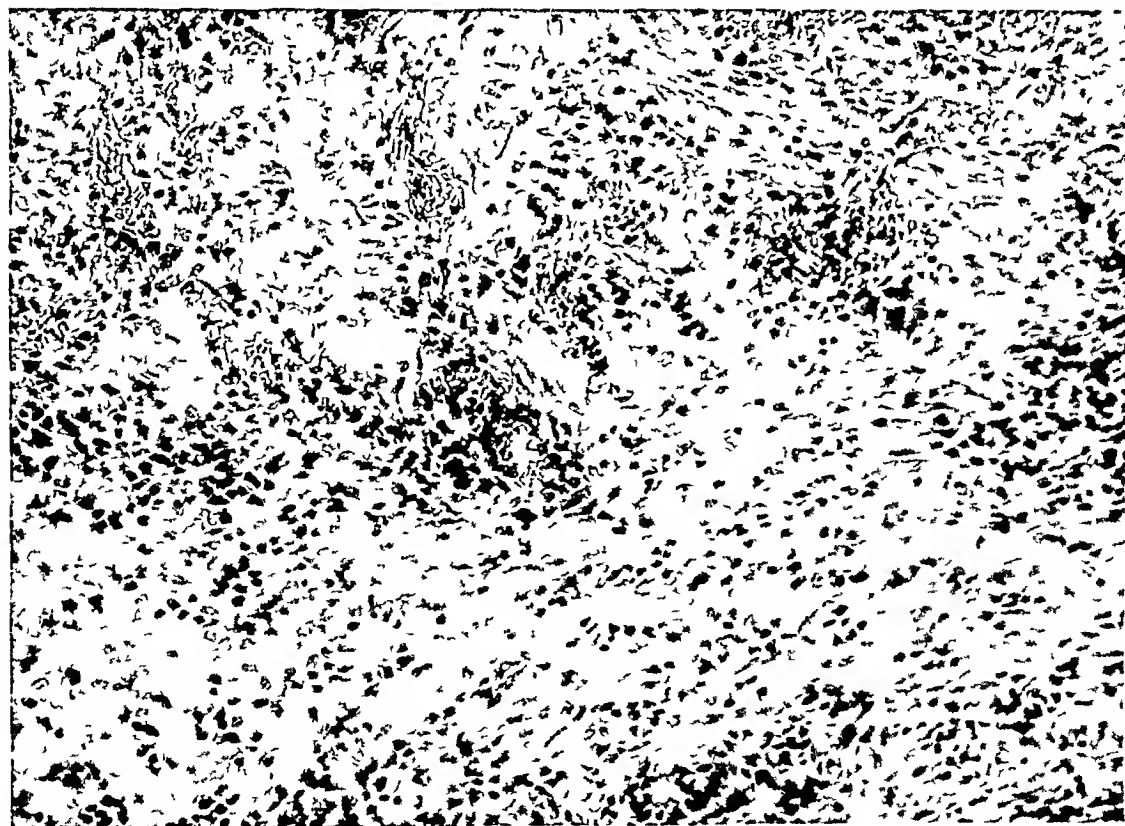


FIG 8—Repair process Particularly about the margins of necrotic areas do intussuscent capillary sprouts of young connective tissue push their way into the resolving debris

proportionately higher. On the other hand, a surprising number of epididymes shows only moderate inflammatory involvement with great pain and without gross pus. Examination of the serosanguineous fluid obtained on puncture of these organs reveals myriads of leucocytes and indicates a mild degree of suppuration—a constant histological finding in early acute lesions.

The pathological histology of gonococcus and non-gonorrhoeal non-tuberculous epididymitis is identical with this exception—resolution is somewhat slower in the gonococcal variety. In each type, however, a definite inflammatory cycle is observed, the changes noted histologically as well as grossly depending on the virulence of the attack and to a lesser degree on the tissue resistance of the host and the treatment employed. These inflammatory processes we broadly classify as acute and chronic. The primary phase of the acute inflammation is exudative or catarrhal, the second phase is suppurative or necrotic. Chronic inflammations are suppurative or, if the repair process is well under way, proliferative. It must be borne in mind that an inflamed organ may show microscopically several stages of inflammation, exudation or necrosis in some parts with repair and sclerosis elsewhere. On the other hand, in each specimen there is usually a predominant process, and the various epididymes studied by us have been classified according to this prevalent inflammatory picture (Table VI). It is interesting to note the increased

TABLE VI
*Pathologic Histology**

Specimens available for study Gc + 22 Gc — 54, Total 76				
Acute		Gc +	Gc —	Total
Exudative		4	4	8
Suppurative		13	25	38
Chronic				
Suppurative		4	13	17
Proliferative		1	12	13
				76

* Tabulated according to the predominant histological picture. In some tissues, all of the above stages may be recognized, more particularly among those removed from cases of recurrent epididymitis.

incidence of the chronic inflammatory phase in the non-gonorrhoeal non-tuberculous group. Unquestionably the absence of venereal infection misleads these patients into a misconception of the severity of their respective lesions and treatment is postponed until prolonged pain and fever is no longer tolerable, or the appearance of signs of gross suppuration, possibly with sinus formation, arrests the attention.

HISTOPATHOLOGY

Of the important histopathological contributions concerning epididymitis perhaps the earliest is that of Scheperlein who, in 1871, first pointed out the destruction of the walls of the ductus epididymis by lymphocytic infiltration with periductal invasion by leucocytes. In 1903, Audry and Dalou described

SURGICAL PATHOLOGY OF EPIDIDYMITIS

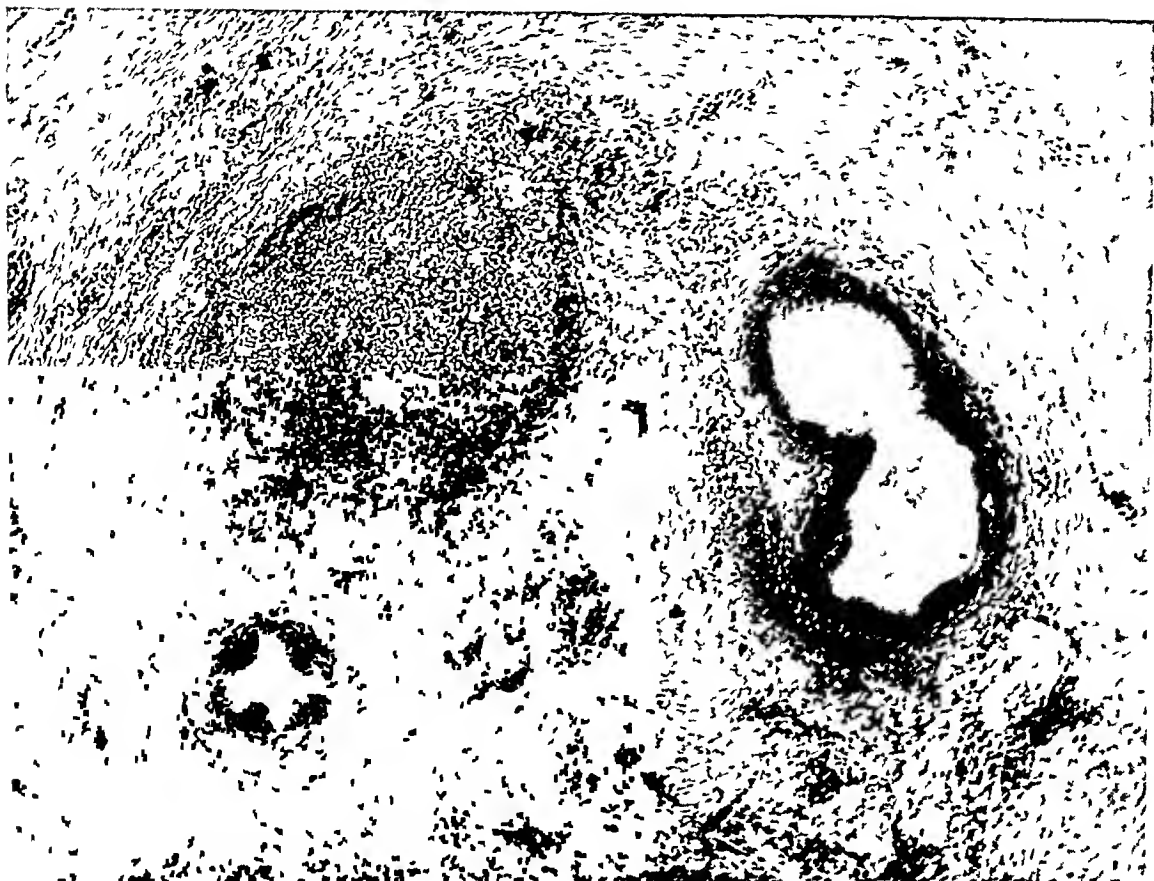


FIG 9 —Peritubular and interstitial sclerosis with persisting tubular abscess. The ultimate conversion of such an abscess into scar is indicated in Fig 10

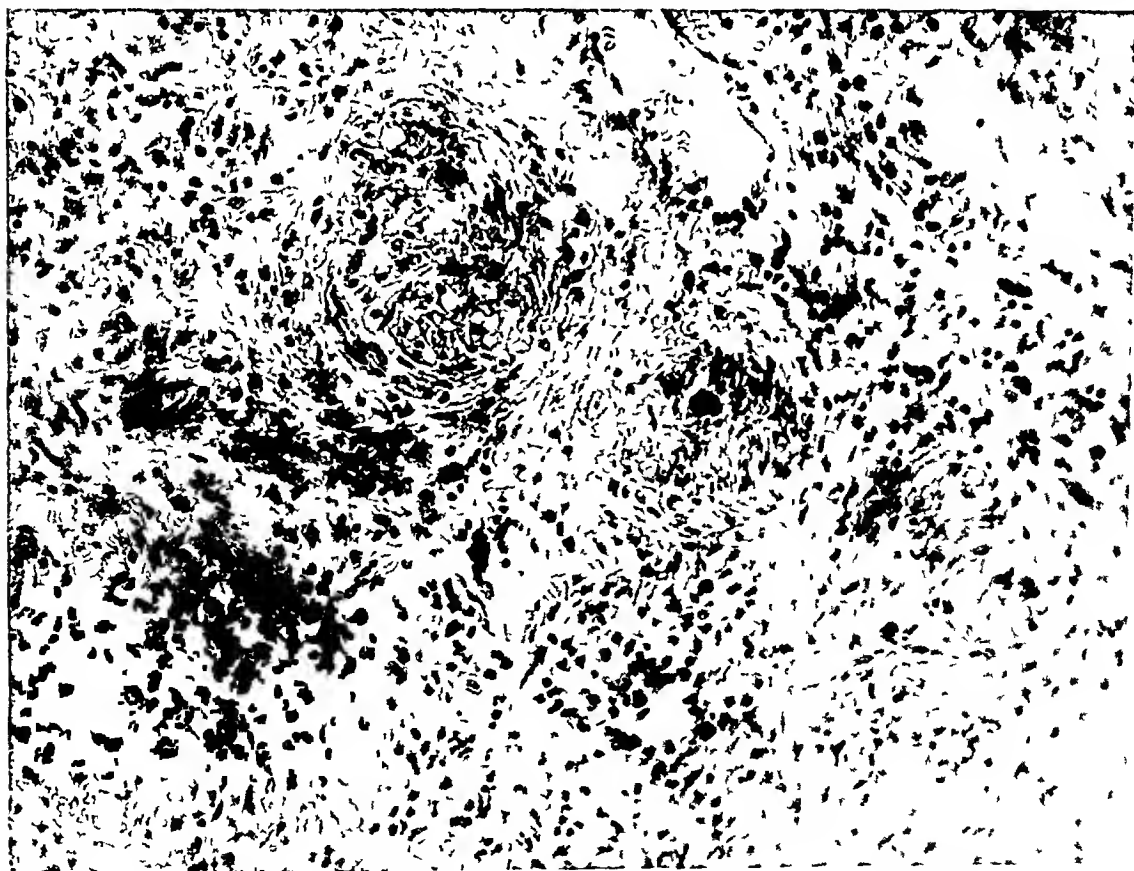


FIG 10 —Replacement of inflamed tubules by scar. Sclerotic end result of many tubular abscesses. Cause of sterility apparent

the formation of tubular abscesses, the infectious invasion of the interstitial tissue and lymphatics, and certain phases of tubular repair. Berman (1905) first demonstrated gonococci in acute lesions and since then others have described various tissue changes in both acute and chronic epididymitis.

Acute Epididymitis—At the onset of the inflammation the process is that pathologically designated as acute catarrhal or exudative. There is cloudy swelling and desquamation of the cylindrical epithelium lining the tubules. This is at once followed by both intratubular and interstitial infiltration with polymorphonuclears, plasma cells, lymphocytes, large mononuclears and a variable degree of œdema (Fig 1). As the inflammation becomes progressively more intense, the leucocytic and œdematous infiltration increases and the underlying vascular changes become pronounced. Enormous acute congestion with massive diapedesis of red blood-cells into the surrounding tissues is seen. While this destructive process is taking place, the phenomenon of vascular repair is well under way and about the periphery of the numerous focal lesions capillary sprouts of young connective tissue push their way into the destroyed tissues. This has been seen within thirty hours after acute onset of the disease.

The transition from the acute catarrhal or exudative stage to that of suppuration is indeed rapid and overlapping, no academic line of demarcation can be drawn. Before the initial process is well begun, microscopic focal abscesses (Fig 2) are evident in the globus minor, so that within forty-eight hours grossly discernible abscesses may be formed by the confluence of several of the smaller. Hence, the majority of acutely inflamed epididymes removed at operation will present histologically, if not grossly, the picture of massive suppuration with generalized tubular destruction and loss of most of the normal landmarks.

Bringing about this picture of gross destruction are certain minute histological changes. With marked infiltration and engorgement of the tubules with leucocytes, the basement membranes are ruptured early and the mass becomes a focal abscess. Leucocytic infiltration is predominantly polymorphonuclear at first, but in some cases the lymphocytes outnumber these cells. Large mononuclear cells appear early and may be numerous (Fig 3). They are best observed within the lumen of the tubules. Œdema is generalized, most pronounced where the inflammatory battle is most severe and gives rise to the characteristic picture of tissue vacuolization—the fluid infiltration of the stroma (Fig 6). Fibrin appears first in the periphery and may later show organization. In two-thirds of the specimens from acute cases we observed hyalin degeneration (Fig 7). Eosinophiles are commonly seen in unusual numbers. Kretschmer and Alexander² noted an increased cell count of eosinophiles in the blood in some of their patients. We did not observe this alteration in the circulating blood, although the increased presence of these cells locally was often notable.

Chronic Epididymitis—As the transition from the acute to the chronic stage is a matter of clinical relativity, so, histologically, does the picture of

SURGICAL PATHOLOGY OF EPIDIDYMITIS

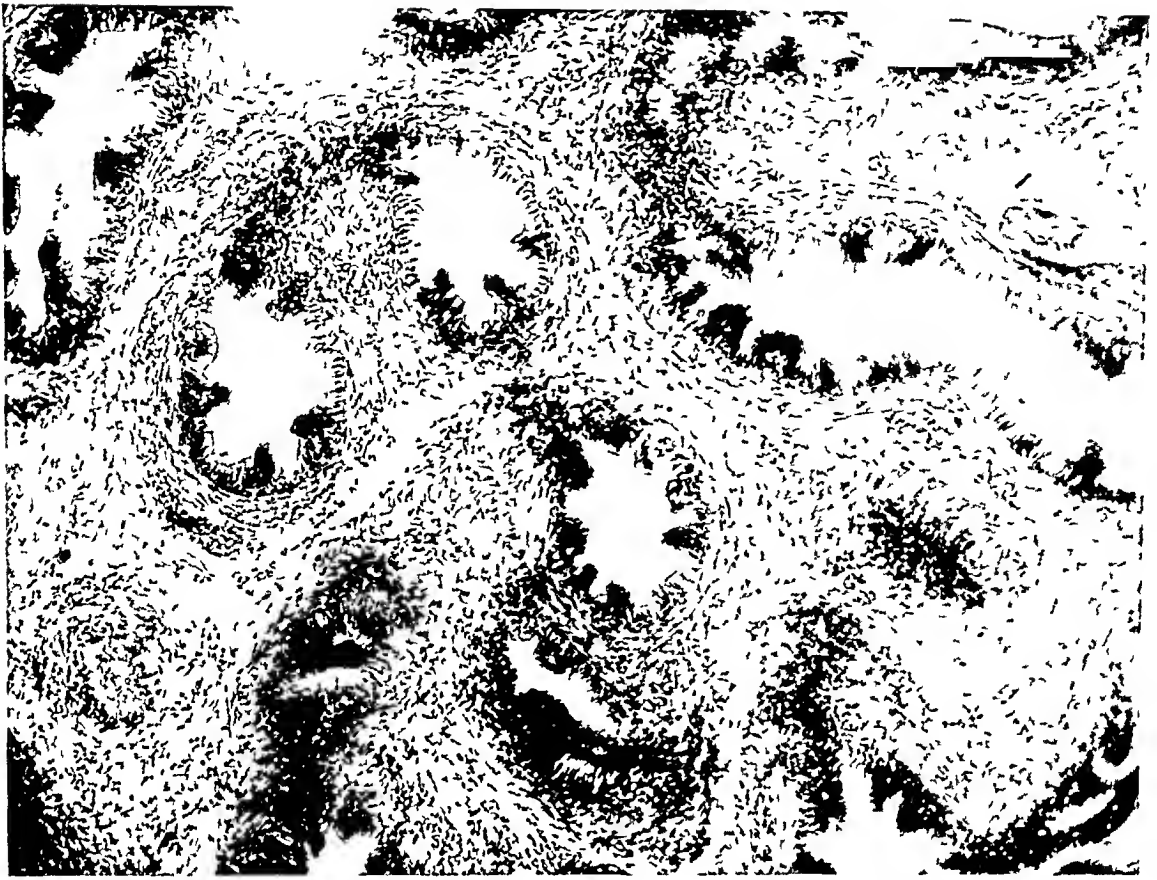


FIG. 11—If the tubules are not destroyed, by peritubular sclerosis with contraction and by proliferation of the lining epithelium, numerous papillary projections into the lumina are formed. See text.

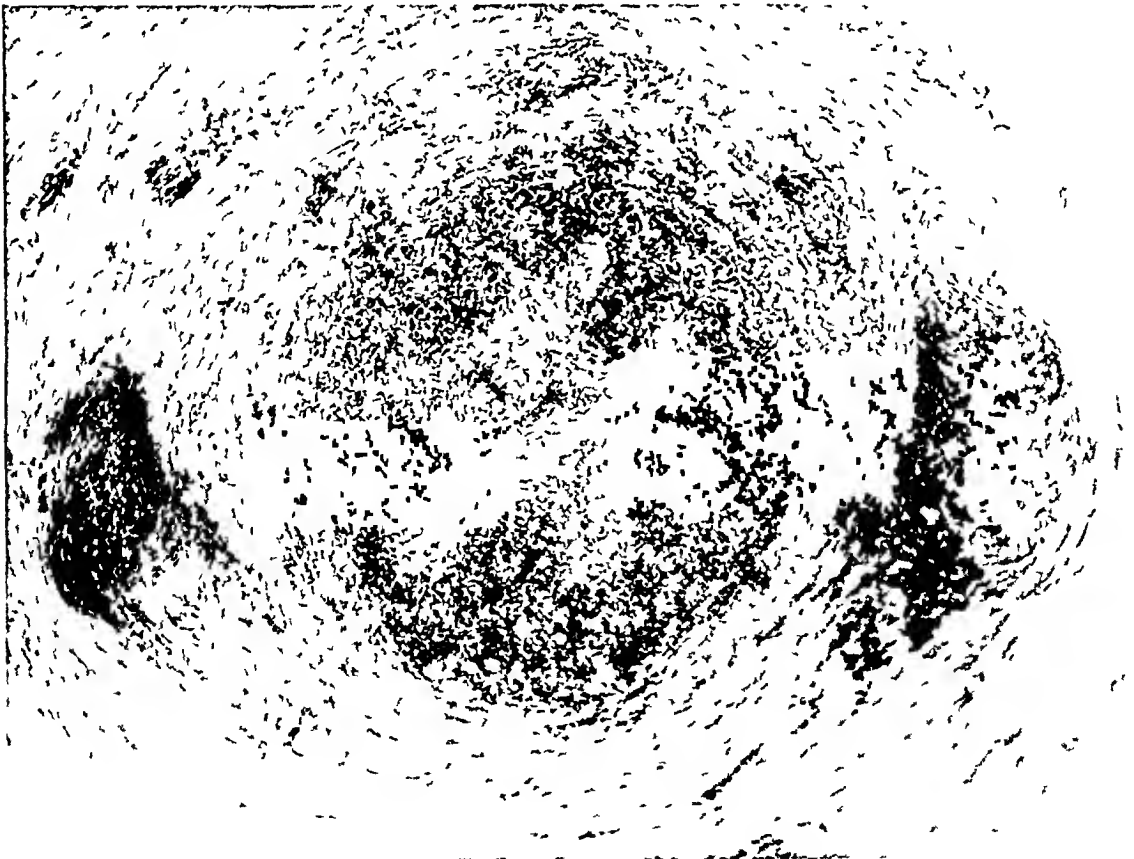


FIG. 12—Acute exudative vas deferentitis with occlusion of the duct and marked infiltration of vasa lymphatica.

late acute become that of relatively early chronic epididymitis. As a rule, a type change in the leucocytic infiltration is observed, lymphocytes come to outnumber the polymorphonuclears. Too, there is a marked increase in the large mononuclear phagocytes, another characteristic of the repair process. Although the epididymis may be a mass of resolving areas of necrosis, vas-



FIG 13 -End result of condition shown in Fig 12. Often the vas is completely blocked by scar—perhaps more often partially occluded as shown in this section

cular and connective tissue repair is everywhere evident, but is most active about the periphery of these abscesses. As new scar is laid down, the massive oedema disappears and by this repair necrotic debris is replaced by connective tissue. Areas showing considerable fibrosis may by compression of the blood-vessels be relatively anemic. While vascular proliferation is universally evident with the formation of myriads of new capillary sprouts (Fig 8) marked thickening of the walls of the older vessels by infiltration, scarring, or perisclerosis occurs (Fig 9).

This sclerosis constitutes the proliferative or terminal phase of the inflammatory process. With the absorption of the exudate and necrotic tissue and its replacement by scar, the remains of many tubules disappear (Fig 10). Other tubules become permanently occluded by post-inflammatory organization, while still others remaining patent undergo hyperplastic changes which are diagnostically characteristic of this stage of the disease (Fig 11). The normal cylindrical epithelium having been lost by exudation, it is replaced by the squamous type. By irregular overgrowth it produces areas of heaped up

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epithelium extending into the lumen of the tubules suggestive of papillomata. Contraction of the tubular walls by intra- and perimural infiltration and sclerosis greatly increases this intratubular intrusion. This squamous cell hyperplasia and sclerotic contraction of the walls may actually occlude the tubules. Bearing in mind this picture of generalized scarring it is not difficult to understand the presence of residual nodular indurations so often clinically palpable twenty years after the acute attack. Most of these persist for life.

Some of our material was removed from patients suffering a recurrent attack and in these specimens all stages of inflammation may be observed. The acute exudative and suppurative phases are found superimposed on a background of tissue previously inflamed but now scarred and indurated. Scarcity of tubules—few if any are normal—and marked overgrowth of connective tissue with a corresponding decrease of vascularity in these areas is characteristic. The clinical recurrence of an epididymitis means the vas and some tubules are still patent and suggests probable fertility of the side involved, although it is conceivable that in these cases the epididymitis results from a lymph borne infection.

Moreover, the histological study of the inflamed epididymis causes one to emphasize not that sterility follows bilateral involvement in over 40 per cent of the cases, but that any of these patients may be fertile following such an attack. Such studies further advance the argument in favor of a liberal attitude toward the early performance of epididymotomy, early drainage presumably will tend to lessen tubular destruction.

Changes in the testicle are those of collateral inflammation. If the attack is of recent onset, acute passive congestion with a variable degree of cloudy swelling may be observed. With suppurative extension from the epididymis, massive destruction of the testicular tubules with ultimate total gangrene ensues. This is not uncommonly seen in those patients whose surgical treatment has been delayed, perhaps the clinical indications for operation have passed unheeded or unrecognized. The testicle is lost by necrotic slough or orchiectomy.

The pathological process in the vas deferens is histologically the same as that of the epididymis (Fig. 12). The lesion is most severe in proximity to the globus minor where abscesses of the duct are occasionally encountered. Repair is a sclerotic process and not infrequently results in occlusion of the vas (Fig. 13) and may account in some instances for the failure of epididymo-vasostomy to cure sterility.

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GENESIS, MORPHOLOGY, AND SURGERY OF PROSTATIC MIDDLE LOBE HYPERTROPHY *

BY ALEXANDER RANDALL, M D

OF PHILADELPHIA, PA

THE unique and uniformly successful development of the clinical surgery of prostatic hypertrophy during the past quarter of a century has now come to a stationary point. The lethal quotient has been brought almost to an irreducible minimum and at the same time a brilliant epoch of clinical advancement and clinical achievement has been recorded. It is another example among many, where under the urge of necessity, by bold and intensive studies, clinical surgery has rapidly outdistanced the fundamental sciences in our knowledge of an organ, but it leaves a tremendous void which must be filled before further advance can be expected.

Taking stock today finds us without accurate knowledge on many fundamental facts in regard to the prostate. For instance, what is the normal physiological function of the prostate? Has it an internal secretion? What part does it play in micturition? What part does it play in our sexual life, etc., etc.? An equal lapse in our knowledge exists when one tries to correlate the various studies on the pathology of benign prostatic hypertrophy. We have not yet decided whether it be an hypertrophy or an hyperplasia. We do not know its etiology, are not in agreement as to where it starts, nor as to how growth proceeds. Residual urine accumulation is no more the simple problem of a dam in the stream, with its pool behind it, than is the wonderful rejuvenation following prostatectomy due alone to better sleep, kidney function, and normal micturition. There are deeper physiological and pathological problems here awaiting investigation. Hence it is that I wish to present to you tonight some studies on the genesis, morphology and surgery of the middle lobe of the prostate, a portion of the gland whose terminology is vague, whose growth is probably the most obstructive, whose diagnosis is difficult and whose surgery is most important, taking for granted that we all recognize today that in hypertrophy the prostate does, at times, form a midline lobular mass which we term clinically a middle lobe.

The point of origin of all prostatic hypertrophies has interested numerous investigators. However, throughout the literature there seems to run a constant tendency to attempt to make one theory of origin or of location to fit all cases of hypertrophy, rarely allowing for variation from one supposedly fixed standard location of origin of growth. For instance, Tandler and Zuckerkandl advanced the theory fifteen years ago that the first changes always occur in the tissue lying in the midline, otherwise called the posterior commissure and that hypertrophy is never absent at this point. Tandler,

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in the 1922 edition of his work with Zuckerkandl spends the greater part of the text in correcting this previous statement and now attempts to prove that the hypertrophy arises superficially to this glandular tissue and presses this posterior commissural tissue backward. This is adopting the work of Motz and Pereaudeau that hypertrophy always originates in the superficial "mucosal glands" closely surrounding the urethral lumen, a point of view that seems to have received rather general acceptance, except in occasional instances. These are but two examples among many of the tendency of investigators to ascribe the origin of hypertrophy to one fixed group of gland acini, a tendency to dogmatize that I cannot but feel is the resultant offspring of studying too small a series of specimens. It has been my experience to find such a variety of types of hypertrophic growth that it has been hard to classify them into groups, and absolutely impossible to bring oneself to feel that the origin and location has been uniformly the same in all cases. In other words it has been impossible to correlate my findings with the idea that hypertrophy invariably originates in or at any one fixed area, or in any one set group of prostatic gland acini. But on the contrary, I believe that hypertrophy may originate in any one lobe of the prostate, with the possible exception of the true posterior lobe. This means that the glandular tissue of the right and the left lateral lobes, the glands of the anatomical middle lobe more truly termed the posterior commissure, and the subcervical gland of Albarran are the tissues sharing in hypertrophic proliferation, and that any one, or any combination of these may be the seat of the origin of the growth.

If one will accept these statements that hypertrophy may originate in any of these locations, it will immediately be appreciated that we should find a marked variety of contours or shapes in different specimens. We should find solitary lateral lobe hypertrophies, solitary commissural hypertrophies, solitary Albarran's subcervical gland hypertrophies, also we should find combinations of any two of these, or all of them together. It has been possible in studying my material to prove these statements but I wish to confine my remarks to the hypertrophies occurring in the midline and obstructing the posterior vesical lip, either as solitary growths or in conjunction with lateral lobe enlargement.

I believe there are two absolutely different enlargements called by the same name of "middle lobe." Anatomically, there are two different glandular elements situated in the midline posteriorly, first the posterior commissural glandular tissue, and secondly, the subcervical glandular tissue of Albarran. Either may undergo hypertrophy independently of the other or independently of lateral lobe growth. Likewise either may grow in conjunction with lateral lobe enlargement, or in conjunction with each other. As they have essential anatomical differences in their attachments and encapsulations, they present a different gross pathological picture and differing surgical problems for their approach and for their successful removal.

The posterior commissural tissue is the anatomical middle lobe, a definite mass of glandular tissue macroscopically visible in normal adult development.

contiguous with the lateral lobe glandular tissue, sharing with them the true prostatic capsule and not showing any independent separating capsule or fibres. This glandular commissural tissue is apparently almost always present, though there appear to be exceptions to the rule, and Lowsley reports such a case in his series of microscopic studies, and Albarran reports four specimens where it was absent in his series of one hundred and eleven specimens studied, and I feel it may be more frequently absent. Possibly in some cases it may be destroyed by inflammation or in others pushed back and compressed, as Tandler would explain it by lateral lobe growth.

On the other hand, when the posterior commissural glandular tissue does hypertrophy, it first causes a thickening and elevation of the posterior vesical lip, and at this stage I have been prone to speak of such as glandular median bars. Macroscopically, at this stage, there may be no evidence of lateral lobe hypertrophy. On further hypertrophy, the commissural tissue raises upward the apex of the trigone, the vesical lip and the first portion of the floor of the urethra. The sphincter gradually drifts backward and behind the hypertrophying mass, and the hypertrophy is constantly confined by the prostatic capsule and always under the trigonal muscle. It ultimately grows to form a thumb-like projection into the bladder cavity, broad, flat sessile, with widely separated clefts in the posterior-lateral angles. In long-standing cases, and those showing massive enlargement, some hypertrophy of the lateral lobes becomes evident, or in my most marked cases, it shares an equal part with lateral lobe growth. It is a stoggy, dullard of a country bumpkin variety as compared to its companion growth, the dainty, artistic, symmetrical, poised and graceful subcervical gland hypertrophy of Albarran.

These latter (subcervical hypertrophies) start as a small rounded nodule just infra-sphincteric and quickly become spheroidal in shape by the time they are large enough to push up through the sphincter, pedunculation has started and from then on this characteristic is never lost and never absent. Its only covering is the mucous membrane and its only attachment its own ducts forming a definite pedicle. There need be no lateral lobe enlargement, and even if present, there being no common capsule, there is no tissue attachment to the same or glandular continuity. It stands alone as a spheroidal, pedunculated lobular mass, and may grow to an equal size of any prostatic lobe.

The query may be put as to which of these do we mean when the term "middle lobe" is used.

The differentiation between these two entities, posterior commissural hypertrophy and subcervical hypertrophy, is not an academic question only, for it is an important matter when it comes to the proper and complete removal at operation and the recognition of the type present pre-operatively should change the technic of enucleation which, if made to suit the case at hand, insures radical and clean removal, minimizes damage to contiguous structure, and lessens the danger of post-operative bleeding.

The differential diagnosis can be made by combined rectal and by cystoscopic study.

PROSTATIC MIDDLE LOBE HYPERTROPHY

The posterior commissural hypertrophy, on rectal examination presents a flattening out of the mid-prostatic groove with a broad flaring out of the upper lateral lobe limits, and a greater tissue mass in the inter-vesicular, sub-trigonal region. Cystoscopically, one appreciates a generalized thickening of the posterior vesical lip, a partial, or complete, obscuring of the trigone and on retracting the instrument one seems to travel a long distance before actually entering the posterior urethra. Clefting, if present, is found far out in the lateral sulci, and if one but follows it, it leads into the posterior urethra without meeting the one from the opposite side, while with an instrument in the urethra and a finger in the rectum, the thickened mass is readily appreciated as the instrument easily stays in the midline and rides over the hypertrophic lobe.

Subcervical hypertrophy, on the other hand, because of its one outspoken characteristic, that of pedunculation, presents easily recognized variations from this picture. It is an intravesical growth and cannot be felt by rectum under any circumstances and when it alone is enlarged the rectal examination may be most unsatisfactory and even misleading. On passing the cystoscope the instrument invariably enters to one side or the other of the lobe which on observation may be mistaken for the rotundity of a lateral lobe enlargement, and sometimes not until one looks directly upward do you catch the change of contour which if followed leads you (and the cystoscope) into the opposite cleft with a complete reversal of the picture. In even moderate sized hypertrophies of this variety it is almost impossible to keep the instrument on the summit of the lobe and follow it into the urethra by drawing the cystoscope outward. But if you follow either lateral cleft into the urethra it will be found to practically meet the one from the opposite side because of the narrow pedunculation. Rectal examination, while the instrument is in place gives no increased thickening, as the instrument regularly lies lateral to the lobe. So one may say that the diagnosis of subcervical hypertrophy is made by cystoscopic examination alone.

Prostatic surgery of today has reached the stage where instead of analyzing the mortality we study the post-operative morbidity of our patients. An ideal prostatectomy, whether done suprapubically or perineally should remove all hypertrophic tissue, restore normal function and last permanently. In order that this may be true, the actual enucleation should be performed by passing through the characteristic line of cleavage and never, if possible, to remove a lobe except in toto and where hypertrophy in one lobe is continuous with other adenomatous proliferation, the enucleation should continue until easy separation of the entire mass occurs.

The surgical deductions to be arrived at from the differentiation between posterior commissural hypertrophy and subcervical hypertrophy are very valuable for the clean, easy and truly surgical removal in each individual case and a pre-operative appreciation of the work ahead expedites the procedure, facilitates a clean enucleation, minimizes hemorrhage and insures permanency of cure.

In *posterior commissural hypertrophy*, when also associated with lateral lobe enlargement, is approached suprapubically, the enucleation, starting intra-urethrally, sweeps about one lateral lobe and should pass across the urethra and the apex of the trigone and the finger goes, without difficulty of any degree, directly around the opposite lateral lobe and the prostatic mass is removed in one piece. If the commissural hypertrophy is present without lateral lobe enlargement, the break through the mucous membrane must be made in a cleft at either of the lower lateral angles of the internal vesical orifice and commissural tissue alone enucleated.

If the approach be from the perineal side, the greatest care must be exercised that a lateral lobe be not removed from either capsule and the commissural tissue (undoubtedly the most obstructive portion) missed entirely. In such a case the Hinman modification of Young's prostatic incision is ideal, and one should again endeavor to keep the adenoma intact and hugging the capsule obtain a single mass enucleation.

In *subcervical lobe hypertrophy*, on the other hand when approached suprapubically the characteristic pedunculation and the knowledge that its capsule consists only of mucous membrane, permits the surgeon to pinch it off the first thing you cannot, nor should not, save its mucous membrane, all of which is redundant and I am in the habit of placing a clamp on the lobe and simply twisting its pedicle to the point of rupture. Occasionally I have ligated the pedicle first but doubt the utility. If subcervical hypertrophy is accompanied by lateral lobe enlargement as well, the suprapubic enucleation entails first the removal of the subcervical lobe, next the enucleation of one lateral lobe, and thirdly the removal of the other lateral lobe that is, one enucleates and removes three separate masses.

In perineal prostatectomy a subcervical hypertrophy presents a peculiar complication all its own. As it does not lie within the prostatic capsule and as that structure is entered on its posterior surface, a complete lateral lobe and commissural growth may be removed and a subcervical lobe hypertrophy missed entirely. Neither can such a lobe be made to present itself into a lateral lobe cavity unless the urethral lumen has been entered and then only the lobe may be dislocated so as to enter first the posterior urethra, then a lateral lobe cavity, and from thence to the perineal exposure. If clean enucleation has been performed on the lateral lobes, the preferable and only way to remove such a subcervical lobe in perineal prostatectomy is to withdraw the prostatic tractor entirely and with a spoon retractor, or lobe forceps, entered through the urethrotomy incision, grasp the lobe and attempt to draw it down through the posterior urethra to a point where its attachment can be ruptured and the mass removed. This complication is the most serious objection to a perineal prostatectomy in such cases, for though its removal can be usually accomplished the possibility of complete oversight, the occasional difficulty of removal, the uncertainty of enucleating such a lobe without leaving behind redundant tags of mucous membrane, and when unusually

large, the complete inability to reduce such a lobe to the perineal field—it being an intravesical tumor—all make me feel that such enlargements belong essentially to the suprapubic operation

Such is the gross pathology of so-called “middle lobes” and their surgical bearing. Factors are present that I feel sure play important rôles in prompt convalescence and complete cures. The terminology has allowed of misunderstandings both in the literature, and in clinical teaching, and in society discussion, and I speak for your approval, that in the future, we eschew the use of the term “middle lobe” and purify our terminology on such occasions by speaking of them as a lobe from either commissural hypertrophy, or from subcervical hypertrophy.

CLOSURE OF THE PROSTATIC BED IN SUPRA-PUBIC PROSTATECTOMY *

By JOHN B. DEEVER, M.D.
OF PHILADELPHIA, PA.

IN THE last several cases of one-stage supra-pubic prostatectomy I have closed the prostatic bed with satisfactory results and shortened convalescence.

The advantage of closing the prostatic bed is that neither the prostatic bag nor gauze packing is required, and that not having to use either, the chance of

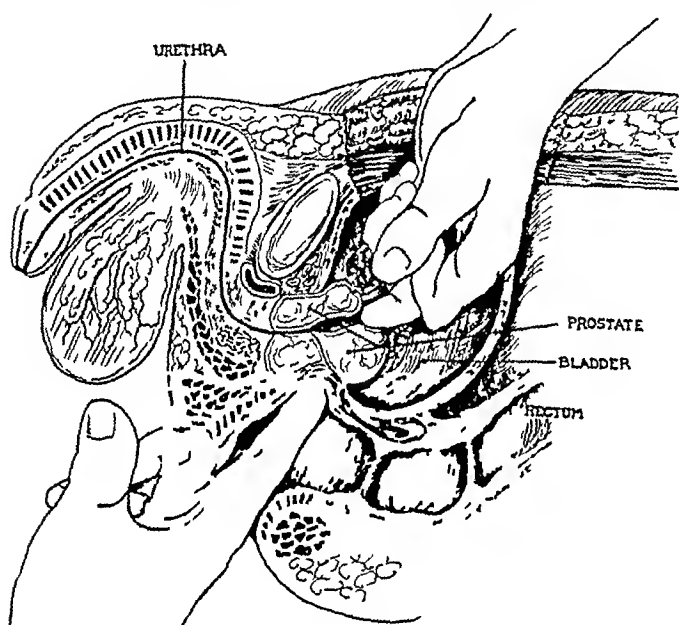


FIG 1.—Sagittal section showing enucleation of prostate by middle finger of left hand aided by finger in rectum pushing the gland upward.

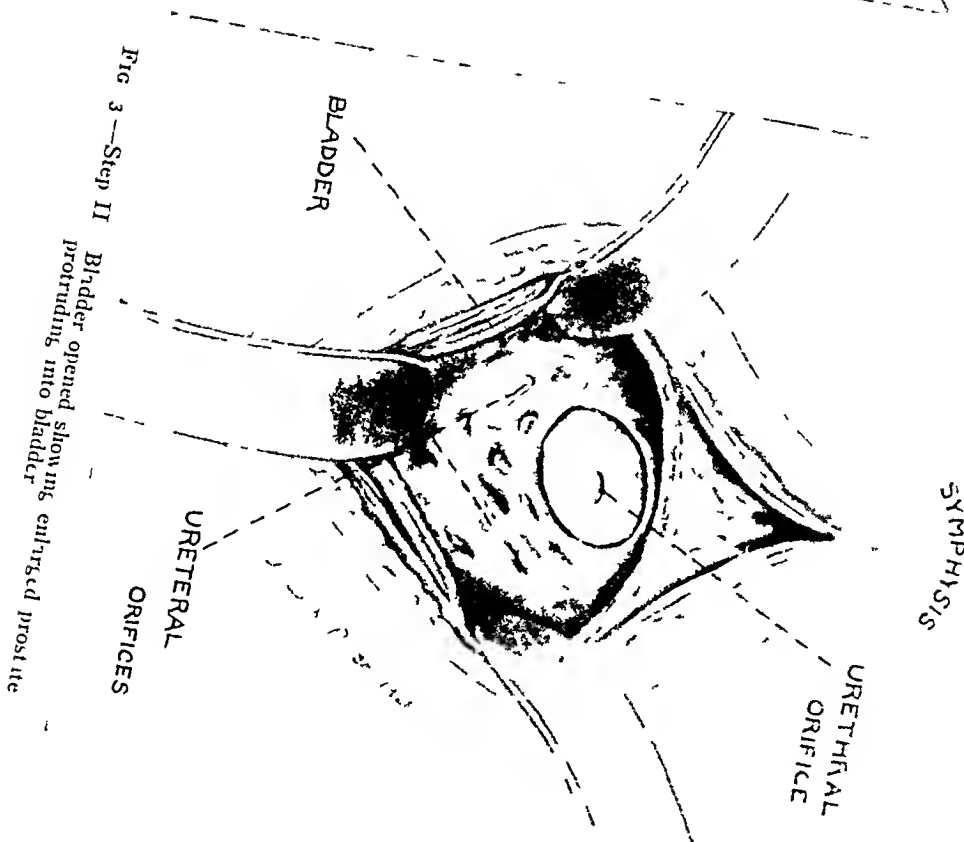
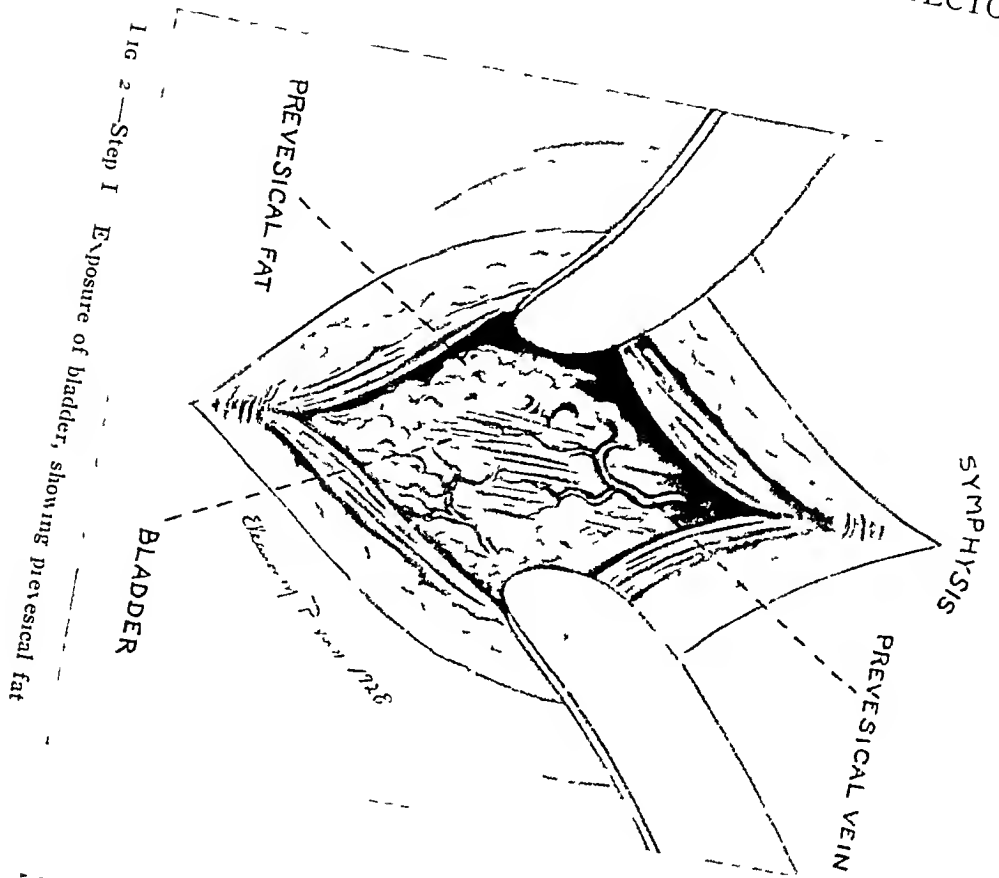
bleeding, especially secondary hemorrhage and infection of the bed is minimized. In the badly infected bladder however, where the smear shows the presence of the colon bacillus or other form of pus-bearing microorganism, closing of the prostatic bed is not advisable. Closure of the bed is not so easily made in the two-stage operation, on account of the more limited space and the lessened flexibility of the tissues following the

primary operation. I now rarely do a two-stage operation, and in the past I have done it only in what were considered "bad risks." At the present time there are fewer bad risk cases than formerly because of our prolonged pre-operative treatment, directed to controlling conditions by catheter drainage and more especially careful consideration of the functional tests. The first-stage operation is now avoided by the use of an inlying catheter which as a rule is practically harmless. In passing I can cite the instance of one patient who wore an inlying catheter for fourteen years during which time not a drop of urine could be voided naturally. In this patient removal of the prostate, on account of other conditions, was out of the question.

Closure of the prostatic bed while not an impossible procedure is not

* Read before a joint meeting of the New York Academy of Surgery and Philadelphia Academy of Surgery, Philadelphia, February 8, 1928.

CLOSURE OF PROSTATIC BED IN PROSTATECTOMY



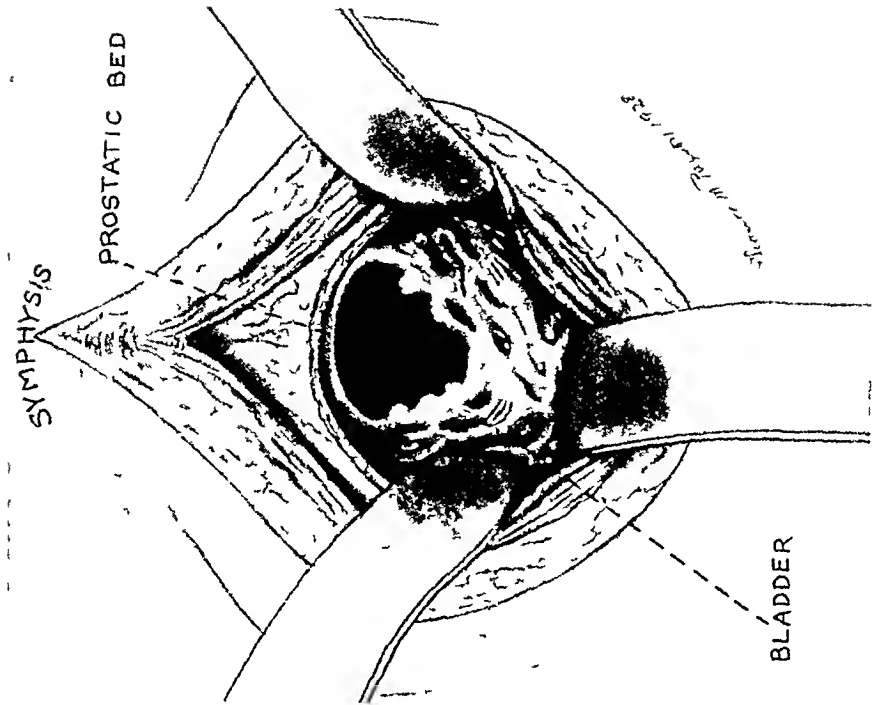


FIG 5 —Step IV Showing ragged hole after enucleation of prostate

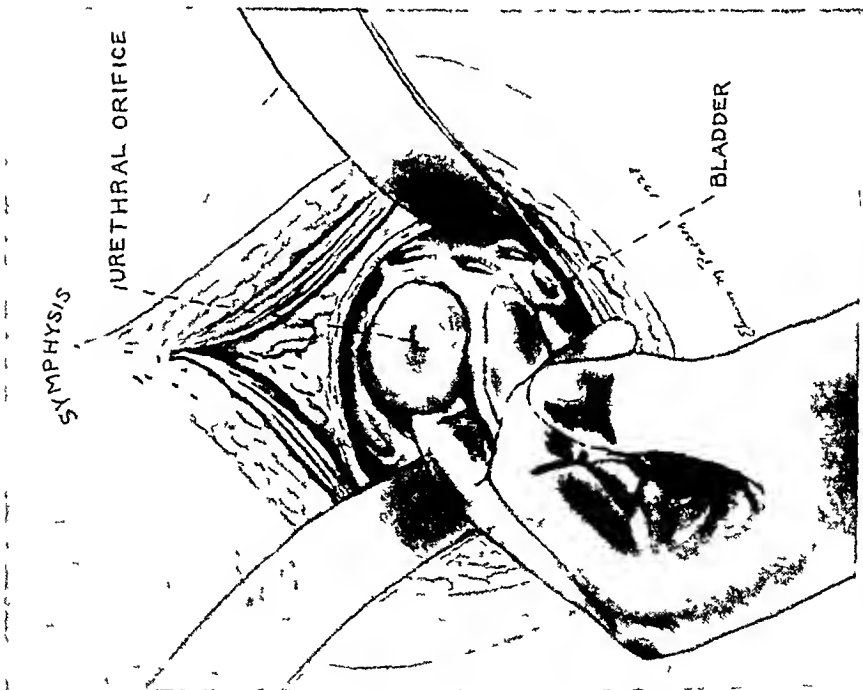


FIG 4 —Step III Enucleating an enlarged prostate with middle finger of left hand

CLOSURE OF PROSTATIC BED IN PROSTATECTOMY

always an easy one. By the following technic it can be satisfactorily done. With the patient under either nitrous oxide and oxygen or preferably spinal anaesthesia, and in the Trendelenburg position, the incision is made and the bladder wound retracted laterally, and fore and aft, using the proper size Deaver retractors, after introducing a small, moist gauze pad into the fundus of the bladder over which the upper retractor is placed so that when traction is made, the floor of the bladder will be level, giving a good view of the wall of the bladder, the prostate, the orifices of the ureters, and after the prostate is removed, of the prostatic bed. The margins of the opening of the bed are grasped and retracted by Allis forceps. The finger of an assistant in the rectum carries the floor of the prostatic bed upward into the opening of the bed where with the aid of a Cameron light bleeding points are seen and ligated and with a curved needle of proper size and shape the walls of the bed are approximated laterally up to the torn end of the urethra. A soft rubber catheter is then carried into the bladder through the urethra and left in a large rubber tube is placed in the bladder and the bladder wound closed up to this tube. I always place a small piece of rubber dam in the prevesical space and remove it on the second day. The supra-pubic tube is taken out as soon as the urine is clear, and the catheter is left in the bladder until the supra-pubic wound has closed, an average period of ten to fifteen days. The convalescence under this method is more comfortable and shorter than by our former methods. The ingenious appliances for carrying out supra-pubic drainage to avoid soiling of the patient's linen are not used in our clinic, in fact I have never used them having been satisfied with drainage through a long rubber tube attached to the supra-pubic tube and carried beneath the bed clothes to the side of the bed and into a urinal tied to the frame of the bed all of which is concealed by the depending bed coverings.

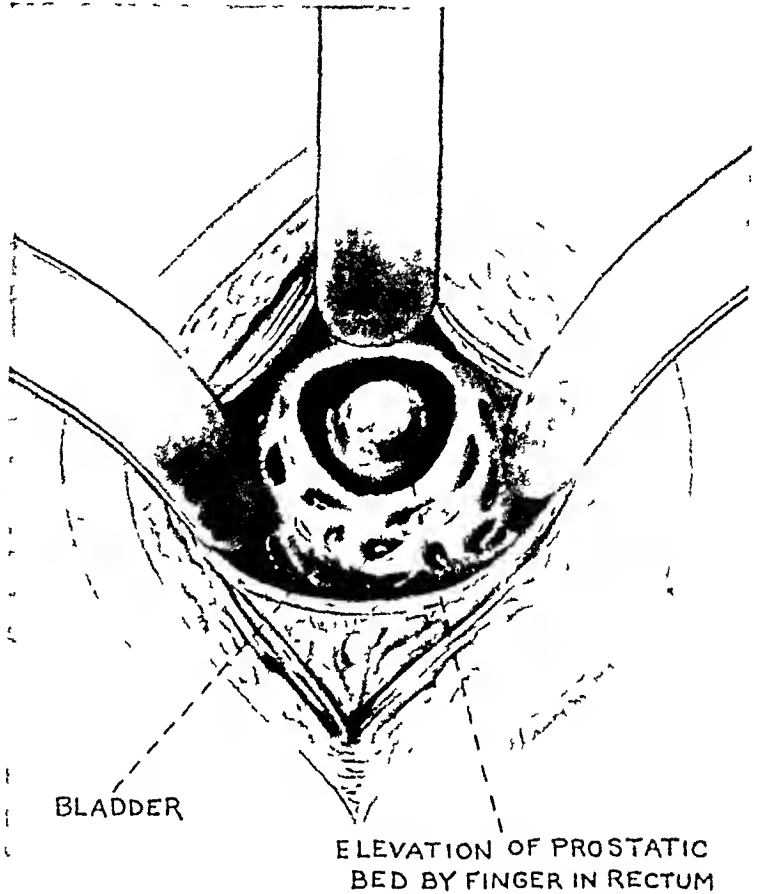


FIG. 6—Step V Prostatic bed elevated by finger in rectum—edges of opening trimmed off

The large prostatic bed with little or no attempt to contract that oozes

freely and does not respond to irrigation with hot water, I have been able to close satisfactorily. In the prostatic bed that contracts promptly and oozes little, there is no particular advantage in suturing except possibly to shorten convalescence.

This is not a new procedure as it has been satisfactorily done by W. E. Lower by whom, I believe, it was first carried out. The technic I have described however differs from Lower's in that as I believe, I make a better

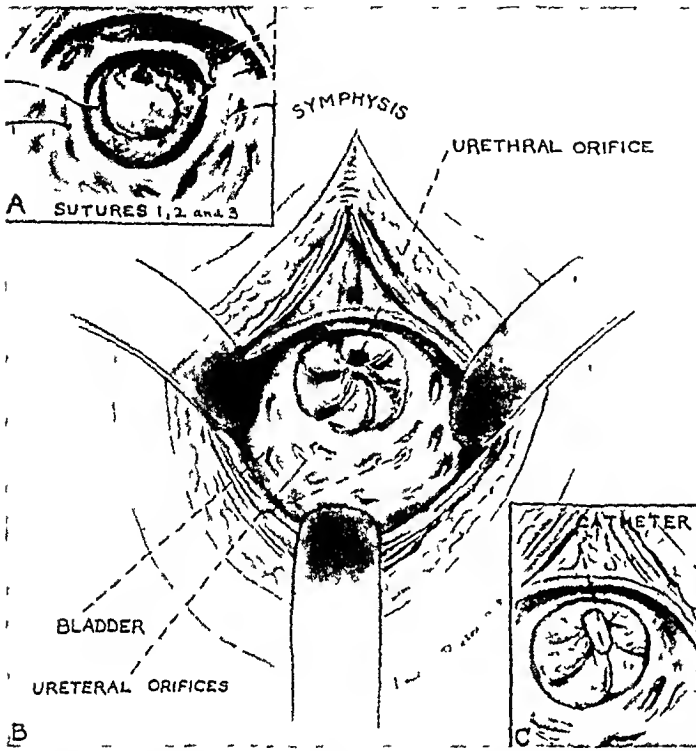


FIG 7—Step VI. A Closure of prostatic bed by three interrupted sutures. B Bed closed, showing urethral orifice. C Catheter in urethral orifice.

exposure. I may be wrong in this, as I have not seen Lower make the closure. My manner of closing the bed also differs from his in that I do not close it around a catheter. In my earlier experience in closing the prostatic bed I did not pass a catheter until the supra-pubic tube was removed. One of the last patients in whom I closed the prostatic bed was eighty-six years old and left the Clinic fifteen days after the operation voiding spontaneously, and in fine condition.

The sutures of chromic catgut number 1 are introduced under the eye

and readily so with the floor of the bed and the anterior wall of the rectum carried upward by the finger of the assistant in the rectum. I have had no trouble in avoiding injuring the wall of the rectum, the assistant's finger being a guide, and the fascial and muscular covering of the bowel being enough in evidence to avoid accidents if gentle manipulation of the needle is observed.

While it is too early to speak of subsequent contraction and stricture, I think this is less likely to occur than after the introduction of a bag or gauze. I have seen stricture following supra-pubic removal of the prostate, one of the causes of a supra-pubic sinus, and necessitating the passage of sounds. In the procedure I have described the catheter is in contact with mucous membrane only, therefore there is less likelihood of subsequent stricture. Up to the present, I have not closed the bladder wound entirely. Please don't go away with the idea that I never make a two-stage operation, for occasionally I do. For example I make use of the two-stage operation where an inlying catheter is not well tolerated, where there is an aggravated

CLOSURE OF PROSTATIC BED IN PROSTATECTOMY

cystitis, and where upon opening the bladder the mucous membrane is chocolate-colored, and bleeds to the slightest touch—in other words toxic—and where there is a large diverticulum with pus retention. Any or all of these conditions can only be properly handled by prolonged supra-pubic drainage.

The presence of stone, papilloma, or diverticulum calls for removal and prolonged drainage following the first-stage operation. I hope I have made myself clear. The removal of a large diverticulum containing a considerable amount of pus usually can be done at the time of the first-stage operation yet this is a question for judgment.

The one-stage operation is an operation in the open throughout, and thus far has given me satisfactory results to say the least, and like other operative procedures the more you do of them, the better and the easier they are. A perfect intra-spinal anæsthesia makes the supra-pubic removal of the prostate a joy shared by both patient and surgeon.

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XANTHOMA OF THE NECK

By CHARLES E HUMISTON, M D

AND

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FROM THE WEST SUBURBAN HOSPITAL

"XANTHOMA" means a yellow tumor. The golden yellow color of the tumor tissue, resembling that of the corpus luteum or of the cortex of the adrenal gland, is due to intracellular accumulation of certain peculiar fatty substances such as double refractile cholesterol ester, protagon, and neutral

fats. After dissolving this ester in the process of preparation of ordinary microscopic sections, the tumor cells assume characteristic "foam" appearance, typical of xanthoma.

There is hardly another problem in oncology, the study of tumors, with so much confusion of ideas, terms and interpretations. In fact, the name "xanthoma" is omitted in some of the modern textbooks because of this confusion. Yet the recent investigations have cleared up many questions concerning the nature of these rare tumor formations, clinical studies have shown their benign

character, and experimental work has cleared up problems of pathogenesis. Therefore xanthoma ought to be a well known nosological unity to every modern physician.

As we have pointed out in cholesteatomas,¹ it is necessary to differentiate in xanthomas between inflammatory and neoplastic growths. Inflammatory tissue formations, containing foam cells, are well known as xanthelasma on the eyelids of persons of advanced age or as subcutaneous lumps in diabetic patients. Lesions of this kind were repeatedly produced experimentally, particularly by Amichkov,² from Petrograd, and his school (see Kusnetzowsky³). After inducing hypercholesterolemia in rabbits any chronic irri-

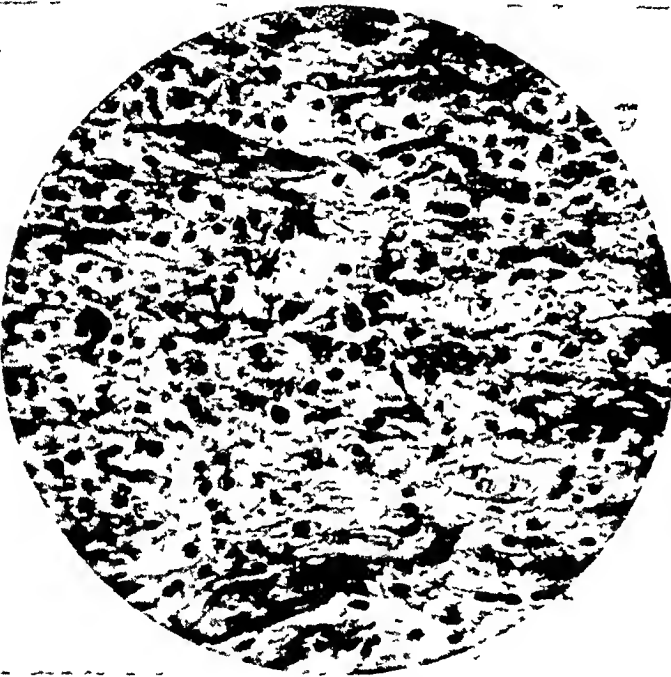


FIG. 1.—Edematous portion of the tumor showing numerous small—vacuolated xanthoma cells in the meshes of syncytium—forming elongated spindle shaped cells. A little off and below the center a plasma cell is seen, marked by an asterisk.

XANTHOMA OF THE NECK

tation will lead to the formation of tissue nodules, which are yellow on the cut surface and contain numerous foam cells loaded with "liquid crystals" of cholesterol esters

Subcutaneous and intracutaneous nodules, having gross and microscopical appearance of xanthoma are well known to dermatologists. These tumor-like formations are mostly small, even if they produce some elevation of the skin—xanthoma planum or tuberosum. The true neoplasmas, "xanthome en tumeurs" of the French writers, are not of common occurrence and are mostly associated with tendon sheaths or joints. Thus Tournieu¹ collected in 1913, 54 cases, Reid⁵ in 1914 described 4 cases, Stewart and Flint⁶ added in 1915, 17 cases, Broders⁷ added the same number of cases, etc.⁸

Xanthomata not associated with tendons or joints are very rare. In recent literature we were able to find only three cases of Smith,⁹ one small tumor being located on the tongue, (apparently rhabdomyoma), one on the labia minora and one in the parotid gland, whereas Lutz¹⁰ described a similar tumor in the mesentery, and Beitzke¹¹ in the meninges. Therefore the publication of an additional case seems to be quite appropriate.

Mrs. Anna G., aged fifty-two, born in Germany, was admitted to the West Suburban Hospital, in July, 1925, with the following history. There had been a swelling in the left side of the neck for several years. Two years before admission the "lump" had been incised and a drain inserted, but no pus evacuated. Recently the "lump" showed increase in size. Movement of the head was being interfered with and there was a change in the voice—a "hoarseness." At no time had the growth been painful—the only discomfort being mechanical interference with the movements of the head. The patient thought she looked like a "one-sided case of the mumps."

Examination shows a tumor occupying the left upper side of the neck. It is deeply situated and displaces the parotid outward. There is marked but not expansile pulsation. The tumor is beneath the parotid but evidently not connected with it. The tumor is very conspicuous even at a considerable distance, and suggests a parotid tumor. The lower limit is rather below the usual site of the bifurcation of the common carotid.

Operation was done July 7, 1925, at the West Suburban Hospital, Oak Park, Ill. A curvilinear incision was made from above downward over the greatest convexity of the tumor. The sterno-mastoid was found to be very wide and greatly thinned. Incision through it permitted most of its muscular mass to be displaced backward. The tumor was found to hug the cervical vertebrae and to have crowded the carotid vessels forward (medial). The internal jugular was displaced from its usual association with the internal and common carotids to the extent of more than 2 centimetres. During the dissection the internal jugular vein was torn and had to be resected. The tumor was distinctly encapsuled and not greatly adherent to surrounding structures, above it was in contact with the base of the skull. Its removal was difficult mostly on account of its size. No large vessels entered the substance of the tumor. On account of the intimate association of the tumor with the carotid vessels a ligature was placed about the common carotid, but it did not become necessary to tie this ligature. The vagus remained in close anatomical relationship with the carotid and appeared to escape injury. The gross specimen on removal measured 9 x 5 x 5 centimetres. The clinical diagnosis at operation was carotid tumor, because of its intimate anatomical associations.

The convalescence was without complication. The scar is now inconspicuous. The voice at this writing, January, 1928, is unimpaired. There is no sign of recurrence.

Blood cholesterol at the time of operation was 310 mgm. Two years later 5-2-27, it was still high—245 mgm. (normal values being 150-170 mgm per 100 cc. of blood).

The tumor removed is ovoid in shape and has the size of a goose egg, measuring 8 x 4 x 4, 5 cm, possesses only a thin capsule, which is rather firmly attached to the surrounding connective tissue structures. It is yellowish on the outside. Its consistency is soft, fluctuating. Upon cutting into the tumor tissue an irregular cystic cavity is found, filled up with bloody serous fluid. The cavity is rather large, the shell being from 0.5 up to 2 cm in thickness. The inner surface of the cyst is bright yellow, rough, and irregular, with many crypts and excavations, showing all the typical earmarks of the cystic degeneration of a primary solid tumor. The tumor tissue of the shell is somewhat lamellated grossly, its cut surface showing white streaks and large, bright, orange yellow spots. A few areas of hemorrhage are present, particularly near the cavity. The predominating yellow shade of the tumor, its soft consistency and cystic degeneration of the central portions lead to the diagnosis of xanthoma on gross examination.

Upon examination of the unstained frozen sections numerous intracellular droplets and needles of highly refractile material are found which dissolve after the addition of absolute alcohol, ether or chloroform. The examination of the unstained frozen sections with polarisation microscope, done by Dr. R. Jaffe, reveals double refractile properties of these inclusions, as manifested by the appearance of crossed diameters in each individual droplet. They react positively to the Sudan III stain.

Examination of paraffin sections (fixation in Bouin's fluid) stained with hematoxylin-eosin, Van Gieson and Alzheimer neuroglia methods (the latter done obligingly by Dr. G. B. Hassin), reveals the following picture. The tumor tissue is rather cellular, many nuclei being present. The tumor is built up chiefly of a syncytium of large spindle cells, which are not separated from each other, but form a continuous single mass of cytoplasm, infiltrated with many vacuoles and containing numerous spindle-shaped vesicular nuclei with fine and uniformly distributed chromatin granules. The spindle-shaped nuclei decidedly predominate in the majority of fields, in some places the cytoplasm is more abundant, in others reduced. In addition to these spindle-shaped nuclei numerous round nuclei with the same distribution of chromatin are present, their cytoplasm being more isolated from the syncytial mass. The round cells are 15-25 microns in size, whereas the spindle cells have the size of a fibroblast. In a few rather isolated spots the round cells assume the typical appearance of foam cells, because of accumulation of fatty products in their cytoplasm but the general character of the nuclei still remains the same.

There are a few peculiar large cells in the tumor, apparently derived from spindle cells by increase in size. They are from five to ten times larger than the spindle cell of the tumor. They possess large vesicular nuclei with a few small clumps of chromatin and 1-2-3 large acidophilic nucleoli. They resemble somewhat ganglionic nervous cells, however, no Nissle tigroid substance is found in their cytoplasm.

In the regions of cystic degeneration some of the round cells undergo peculiar changes. They increase in size, separate themselves from the underlying structure, assume epithelial-like appearance, form some sort of inner lining of the cyst cavities and not infrequently transform into multinuclear giant cells.

The essential cellular constituents of the tumor are therefore (1) syncytium—forming relatively large spindle cells, some of which apparently give rise to the formation of large "ganglion-like" cells with eosinophilic nucleoli, and (2) round cells, transformed in some places into "foam" cells, or rarely, into epithelial-like or multinuclear giant cells, the latter processes being confined to the area of cystic degeneration.

The interstitial connective tissue, stroma of the tumor, is by no means an abundant one. Only here and there an individual collagen fibre is found. A few layers of collagen fibres form a thin capsule on the periphery of the tumor. The blood-vessels are not numerous and show marked hyaline changes, the wall being thick and structureless, the endothelium rather swollen. The retrogressive and even inflammatory changes therefore are quite prominent, also foci of plasmocellular and lymphocytic infiltration, foci of intra-

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cellular hemosiderin deposits are found. A quite striking feature is rather diffuse distribution of isolated plasma cells, which may have even some diagnostic significance. The numerous small cyst cavities, due to colliquation necrosis, are filled up with coagulated granular or amorphous material and usually show also some sort of epithelial-like lining, the origin of which was already discussed. The lymph vessels or spaces are not numerous and apparently do not play such an important rôle, in our case, as is usually assigned to them in cystic degeneration of other solid tumors, as for instance, in leiomyoma.

On the sections stained with picrofucsin the cytoplasm of the syncytium stains definitely yellow, contrasting with the pink collagen fibres of the stroma. On sections stained by the Alzheimer method the syncytium does not give typical glial reaction, remaining light blue, but the contrast with the deep blue collagen fibres remains well pronounced.

The association of xanthomatous growths with hypercholesterolemia in experimental conditions, as well as in many cases of clinically observed patients—found also in our case—is of the utmost importance. One is justified in assuming that the high concentration of fatty substances in the blood may even play the rôle of causative factor, just like formation of “tophi” in gout. In other words, if in cases of gout the excessive amount of uric acid is deposited in certain tissues, in “xanthomatous diathesis” the excessive amount of fatty substances may be deposited in loose connective tissue, which normally stores the excess of fat. Therefore it is advisable to try to reduce hypercholesterolemia by some dietetic measures before using more radical methods of treatment. Fat-free diet is indicated, brain and eggs are particularly undesirable.

Xanthomata are essentially benign (Bloodgood¹²). Resembling granulation tissue, even when they form tumor masses, they are not definitely isolated from the surrounding structures, possess no firm capsule and simulate therefore a so-called infiltrative type of growth, a picture of “histological malignancy.” That is the reason why they are usually called even now “xanthosarcoma.” The analysis of the cases described fails however, as a rule, to reveal any definite and unquestionable signs of clinical malignancy. The addition of the word “sarcoma” is therefore not justified from the clinical standpoint, nor from the standpoint of the patient, which ought not to be neglected. Only in very few instances, as for instance in the case of Dietrich,¹³ the malignant tendency of xanthomatous growth seems to be more evident. The only way to get rid of the term “histological malignancy” is by the painstaking accumulation of data in the subsequent clinical course such as is now being done by the leading clinics of this country.

But not all yellow tumors are benign. Many hypernephromata are malignant enough in spite of the presence of yellow areas on the cut surface. On the other hand high grade lipemia may probably be responsible for the yellow discoloration of many different tumors, through intracellular deposits of the above mentioned lipid substances. In recent literature Gaulh¹⁴ mentions several cases of “carcinoma xanthomatodes” (Dubs in the fundus of the uterus, Kinoshita in the prostate, Petri in the stomach), also a case of “thymoma xanthomatodes” by Kneinger and Preisel. Many other cases of different tumors, containing abundant intracellular deposits of double refrac-

tile cholesterol needles and droplets have been described. Not uncommonly foam cells are found in benign tumors such as giant cell tumors, epulis, mammary fibroadenomata, etc., and even in inflammatory conditions, particularly in different forms of mastitis (Kadji, see¹⁴). Histological examination determines the nature of the process.

SUMMARY

- 1 The clinico-pathological entity of xanthoma is important
- 2 Xanthoma is essentially a benign tumor, in spite of its "histologically malignant" structure
- 3 The cases of xanthomatous formations (skin, tendon sheaths) associated with hypercholesterolemia ought to be given trial with suitable diet before undertaking more radical methods
- 4 True tumor formations of xanthoma type not associated with tendon sheaths of joints are extremely rare. A case of xanthoma of the neck is reported
- 5 From microscopic standpoint, the most essential cellular elements of xanthoma are (a) spindle cells, (b) round cells, (c) foam cells (xanthoma cells), (d) giant cells, (e) isolated and diffusely distributed plasma cells

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TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY AND THE NEW YORK SURGICAL SOCIETY

Conjoint Meeting Held February 8, 1928

DR ASTLEY P C ASHHURST, in the Chair

DR CALVIN M SMYTH, Recorder

POST TRAUMATIC ANKYLOSIS OF SCAPULA TO RIBS

DR J TORRANCE RUGH presented a man aged forty-two years, who was first seen April 6, 1925, because of limited movement in the right shoulder and some pain on attempted work. February 10, 1925, while working, he fell, striking heavily on his right shoulder and back. The arm was said to have been dislocated and promptly reduced by a physician and the arm bandaged for a while. An X-ray was taken which showed fracture of the sixth and seventh ribs under the lower portion of the scapula but under adhesive strapping these promptly healed. When the bandages were removed and mobilization of the arm and shoulder was begun, the scapula was found to be fixed though scapulo-humeral movement was fairly free. When the reporter first saw him, an X-ray made nearly six weeks after the accident, showed a dense area of bone deposit under the scapula and over the site of the rib fractures. This area measured about 4 cm vertically and horizontally and was of equal density throughout. He also presented several deep scars in the skin on the right side of his spine between the scapula and the vertebral spines which the patient said came from abscesses in that part following typhoid fever at the age of nineteen years. Careful inquiry revealed that there had been no limitation of shoulder and scapular motions and that he had played ball for years, pitching part of this time. One would naturally be suspicious that the abscesses rather than the injury might have caused the fusion but the very clear and positive history of free use for the intervening years seems conclusive. Attempts at mobilization of the scapula were made by masseurs but failed. May 15, 1925, a curved incision with the base external was made about the scapula, the skin reflected back about two inches and a flap of fat then lifted with the base toward the spine and ventral to the posterior scapular border. The fascia and the rhomboid and latissimus muscles were then loosed from the scapula, and directly beneath the scapula was found a plate of bone holding it to the ribs. With a broad osteotome, the scapula was first loosed from the bony mass and lifted upward and then the plate of bone was cut loose from the ribs. It was about four cm in both directions and one cm in thickness. After smoothing both denuded areas, a flap of fat was slipped beneath the scapula and held in place by several sutures. The latissimus and part of the rhomboid were then sutured in place and the skin closed. Recovery was uneventful and in two weeks mobilization and massage were begun. Improvement has been gradual and steady until now the arm has even more free action than the left one.

The interposition of the subscapularis, the serratus magnus and coarse areolar tissue furnishes most effective protection against fusion between the scapula and the ribs, but the only explanation in this case is that the rib fractures must have penetrated the muscle structures and injured the under surface of the scapula as well.

DR FREDERICK BANCROFT, of New York, said that the formation of bone may be divided into repair of bone following injury and infection, experimental extra-skeletal bone, and pathological bone. Experimentally bone has been produced in animals by ligating the renal vessels and placing omentum over the kidney. In one or two months sections of the kidney show areas of true bone formation and areas of calcification occurring in the kidney parenchyma. This bone is true lamellar structure with bone cells and Haversian canals. In rabbits it may be produced by scraping the adventitia of the aorta and painting it with either silver nitrate or copper sulphate. Doctor Neuhof, working in the surgical research laboratories of the College of Physicians and Surgeons of Columbia University, has shown that in placing fascia lata transplants to cover defects in the bladder, bone is almost universally formed in these transplants. This tissue, both microscopically and chemically, resembles skeletal bone.

Bone is born pathologically in almost every region in the body. It occurs in the ovaries, in the lymph-nodes, in the adventitia of arteries, and in thyroid tumors. It frequently occurs in old hæmatomata. If then we are to produce any theory for bone formation, it must be broad enough to cover repair of bone following injury and infection, experimental and pathological extra-skeletal bone. There are three main theories for bone repair: 1. Periosteal and endosteal formation of bone. 2. Osteoblastic formation of bone. 3. Deposition calcium salts on the connective tissue stroma. The periosteal theory cannot account for the extra-skeletal bone formation. It is true that periosteum is an ideal site for bone formation. It has an outer fibrous layer and an inner layer of areolar tissue with finely divided blood-vessels. In the speaker's study of microscopic sections of bone repair he found that bone is laid down in areolar tissue in the extravascular areas. One will see a small blood-vessel surrounding which is an area of areolar tissue, and at the perivascular area is new bone. The osteoblastic theory assumes that osteoblasts are set free from the bone lacunæ, that they multiply and secrete new bone. It is difficult to account for the localization of these osteoblasts in fascia lata transplants of the bladder, such as seen in Neuhof's work. If fibroblasts may turn into osteoblasts by a process of metaplasia, all types of bone formation may be accounted for. The third theory assumes that through the change of the hydrogen-ion concentration calcium salts are deposited on the stroma or connective tissue, but the cell, the fibroblast, is only a passive agent in the production of new bone. The fibroblast then becomes a bone cell through functional adaptation. This theory, Doctor Bancroft believes, is the most convincing—and the simplest. It means that if the proper environment is created, bone formation will inevitably follow.

In Doctor Rugh's case, the etiological factors were trauma—resulting in the fracture of ribs—and extensive hemorrhage in the surrounding muscles, diminished blood supply due to the Velpeau bandage, which produced diminished expansibility of these tissues, as on one side there were ribs and on the other side the scapula. These factors are ideal for the formation of bone.

UNDESCENDED TESTICLE

The advance in our knowledge of bone formation is going to come through bio-chemical studies rather than through the microscope. In the microscopic study of bone repair there is no clear differentiation of the cellular elements. One sees definitely connective tissue and cartilage cells, bone cells and connective tissue cells, but in the intermediary areas it is difficult to tell whether a cell is a connective tissue cell or a bone cell, a connective tissue cell or a cartilage cell, and a cartilage cell or a bone cell. It is for this reason that it is hard to assume that there is any specific cell in bone production.

UNDESCENDED TESTICLE—OMBRÉDANNE'S OPERATION

DR ASTLEY P. C. ASHHURST presented two lads on whom he had operated, by Ombredanne's method, for undescended testicle.

CASE I—Was fifteen years of age. His right testicle lay in the inguinal canal visible as a small swelling. Operation June 29, 1927, at the Episcopal Hospital. After making the usual incision for inguinal hernia, and dissecting the testicle and cord free from the internal ring and inguinal canal, a second incision was made transversely into the left half of the scrotum, and the scrotal septum incised just enough to permit pulling the right testicle through into the left scrotum. The opening in the septum was closed snugly around the cord just above the testicle, and the scrotal incision closed, the inguinal canal was closed without transplanting the cord after excising the sac of the indirect inguinal hernia.

The patient now presents a well formed scrotum, both testicles lying loosely in its left half. The boy is unable to tell on palpation which of the two testicles is the right. The testicles lie more or less one above the other, and as the upper testicle is smaller, it is probable that this is the right testicle.

CASE II—The second patient, aged seven years, had both testicles undescended. The right could be felt in the inguinal canal, but the left was not palpable, the scrotum was undeveloped. Operation October 12, 1927, at the Episcopal Hospital. Both inguinal canals were opened. On the right the epididymis was found at the external ring, with the testicle in the inguinal canal, on the left the testicle (smaller than normal) was adherent at the internal ring. There was a well formed hernial sac on the right but none on the left side. After dissecting both testicles and spermatic cords free from the inguinal canals and internal rings, a transverse incision was made across the front of the small scrotal pouch, exposing both sides of the septum separating the left from the right sides of the scrotum. This septum was then perforated, and the left testicle pulled through the perforation into the right side of the scrotum and the right testicle through the same perforation into the left side of the scrotum. The opening in the septum was then closed snugly, around the crossed spermatic cords, the incision in the scrotum was closed, and both inguinal canals repaired as in the first case, after excising the hernial sac on the right and repairing the parietal peritoneum on the left where it had been opened to permit bringing the testicle down toward the scrotum.

The boy, who is otherwise well developed for his age, now presents both testicles normally mobile in a well developed scrotum. The left testicle (lying in the right scrotum) is still somewhat smaller to palpation than is the right.

DOCTOR ASHHURST added that this method of operation for undescended testicles was described by Ombredanne in 1911 but it seemed to have attracted

little attention in this country. He was impelled to put these cases on record because of the report by Dr K P A Taylor at the December, 1927, meeting of the Academy of an operation done in two stages: the testicle first is sutured to the patient's thigh, to keep it from retracting into the inguinal canal, and is cut loose from the thigh only after some months. Doctor Ashhurst had found it difficult to keep the testicles well down in the scrotum after operations on cryptorchids, until he had adopted Ombrédanne's method, which has the advantage over that just mentioned (known by the name of Torek) of being completed in one stage, besides being just as efficient.

DR DEWITT STETTEN, of New York, said that personally, he had had no experience with Ombrédanne's operation for undescended testicle because he has always been quite well satisfied with the method described by Davison in *Surgery, Gynecology and Obstetrics*, in March, 1911. This consists in complete division of the posterior wall of the inguinal canal, including ligation and division of the deep epigastric vessels, thorough isolation and mobilization of the spermatic vessels and the vas, and a lowering of the entire cord by a reduction of the looping of the vessels and vas to their straightest and most direct course possible, a Ferguson hernioplasty, and then subsequent gentle elastic traction on the testicle in the scrotum by a rubber band. At the Lenox Hill Hospital a number of the surgeons, notably Doctors Torek, Eggers and H W Meyer, have been using the Torek two-stage operation, or as it is sometimes called, the Keetley-Torek operation, with exceptionally good results, as Doctor Meyer has reported in *Surgery, Gynecology and Obstetrics* in January, 1927. They had not been very enthusiastic over the Bevan operation, particularly since Moschcowitz showed experimentally that the vitality of the testicle was jeopardized by ligation of the spermatic vessels, and that, practically, atrophy of the testicle was not an infrequent sequel. Further, they had had at least one case at the Lenox Hill Hospital several years ago, in which there was a complete sloughing of the testicle following this operation. Two theoretical objections might be offered against the Ombrédanne method of transscrotal transplantation of the testicle through the septum to the opposite side of the scrotum, are: 1. In unilateral cases it tends to displace the normally situated testicle somewhat higher than it should be, and, 2. In bilateral cases it requires an operation on both testicles at the same time. This latter feature the speaker considers particularly objectionable as he believes that one testicle should be operated on at a time to see what the end result will be, particularly as regards the vitality of the gland, before the operation on the other side is attempted. If necrosis of the testicle occurred after the first operation, which is by no means impossible, then it would be inadvisable to risk operating on the other side—for, although it is generally conceded that the possibility of eventual spermatogenesis in even a reduced ectopic testicle is doubtful, it is also more or less agreed that such a testicle is not without value in influencing the sexual development of the individual through its internal secretion. If there is a lack of development of the scrotum, the Ombrédanne method is definitely contraindicated. This applies particularly to the bilateral cases. This lack of development of the scrotum

is especially well taken care of by the Torek operation. A serious practical objection that has been advanced against Ombredanne's technic and that has led a number of surgeons to abandon it, has been that in cases in which the transscrotally transplanted testicle becomes necrotic, an infection may develop which may involve and threaten the normal testicle.

DR FRANZ TOREK, of New York, said that these two cases show that the testicle which was brought out of its former place has remained in the scrotum, but the result in these two cases is not ideal. In the case of the larger boy, the transplanted testicle is at a position about midway between the position of the normal testicle and the pubis, too high up for an ideal position. In the case of the smaller boy, both testicles are very high up, close to the pubis and especially the right one which can scarcely be felt. It is probably a case of atrophy which no surgeon can control by any operation. The ideal result of operation is one which brings the testicle down into the bottom of a well-shaped scrotum. The speaker never practices the Ombredanne operation. Looking at it from a clinical standpoint, as Doctor Stetten has pointed out, it has occurred that the transplanted testicle occasionally becomes gangrenous, that ought not to happen, but nevertheless it has occurred a number of times. If a testicle is transplanted, that will become gangrenous, into the opposite side—where there is a normal testicle—the risk is taken of also destroying the other testicle by infection, and this may be a theoretical objection to the operation. In the case of both testicles being undescended, as in the smaller boy, there is practically no scrotum, or very little, and the testicle cannot be expected to be well down in the scrotum, if there is no such receptacle to hold it. There is no better way of making a scrotum than by attaching the scrotum to the thigh, as in the Torek operation. The fact that the testicles are crossed can not form a better scrotum. The cases operated upon by the speaker's own method have been perfect operative successes. One cannot make a sterile person function again—although in one case the operation was done on a married man who eight years afterward became the father of a child, so that there is a possibility that the nutrition given by the attachment to the thigh may be of some value.

DR FRANK S. MATTHEWS, New York, said that it would be to the advantage of any surgeon interested in the general subject of testicular descent and the function of the scrotum to consult an article by Carl Moore in the first number of the *Quarterly Review of Biology*, called "Biology of the Mammalian Testis and Scrotum." The question of the migration of the testis into the scrotum in some animals and its retention in others has always seemed difficult to explain. Comparative anatomy does nothing to clear up the subject. Moore's paper, covering previous work and his own contributions to the subject, make interesting reading. It seems demonstrated that the scrotum is a heat-regulating mechanism, the absence of fat, abundance of sweat glands and the cremasteric reflex facilitating its functioning. Differences of temperature in the scrotum and abdomen have been recorded from one to five degrees centigrade. A thick covering has been applied to the

scrotum in animals and, on killing them a short time afterward, all the cells (except the Sertoli cells) lining the tubules are found disintegrated. Testes of adult animals transplanted under the skin of the abdomen always show disappearance of spermatogenic cells. If the transplantation has not too long continued, replacement in the scrotum will end in regeneration. Wagenseil in the March, 1927, *Archives of Surgery* has added something to the subject. He has shown that there is comparatively little growth in the testis from birth up to ten years. After this, when maturation has taken place, if the testis is either replaced in the abdomen or even under the skin of the abdominal wall, the degeneration which results cannot be recovered from by returning the testis to a normal scrotum. A Japanese transplanted both testes under the skin of the abdomen and constructed a cooling apparatus which he applied to one of the testes with the result that degeneration in the tubules was prevented on the side to which the cooling apparatus was applied. It would seem as though in transplanting the human testis into the thigh of the child by the Torek method, no great harm to the organ would be done but that if the same operation is performed after puberty, that spermatogenic function would be destroyed.

BURN SCARS OF CHIN AND NECK TUBE-PEDICLE FLAP

DR ROBERT H. IVY presented a man, aged thirty, referred by Dr. Calvin M. Smyth, Jr., September 8, 1927, with marked scarring and contractions of chin, lower lip and neck, resulting from burns when he fell into an open fireplace eight years before. He had already had about twenty-five operations. The chin was still bound to the chest by dense scars, obliterating the profile of the neck entirely, and causing some prolapse of the lower lip. He has been operated upon in several stages as follows:

September 16, 1927. Preparation of tubed pedicle on left side of back along inner border of scapula.

September 30, 1927. Flap raised on back at lower end of tubed pedicle and sutured in original bed for delayed transfer.

October 14, 1927. Excision of scar tissue beneath chin and flap from back swung by tubed pedicle over left shoulder and sutured into raw surface on front of neck.

November 4, 1927. Proximal end of tubed pedicle severed and swung around into chin and lower lip above flap on neck.

November 18, 1927. Loop between two ends of transferred tissue divided and sutured smoothly in place. By this means the contracture of the neck was abolished, the profile of chin restored and the lower lip brought up into place. The flap from the back has proved very satisfactory in this and another case in furnishing the desired amount of tissue from a concealed part of the body. It was unnecessary to fix the head and chest by a plaster case during the transfer, but in a child on whom a similar operation was successfully performed plaster-of-Paris fixation had to be used.

BONE GRAFT OF LOWER JAW AFTER RESECTION FOR TUMOR

DR ROBERT H. IVY presented a man, aged twenty-eight, who gives a history of having a large portion of the left side of the mandible resected by Dr. John B. Deaver at the age of eight for a tumor. When first seen he presented a healed defect of the left side of the lower jaw three inches in length. There remained on the left side a small portion of the ascending ramus

GASTRIC ULCER—BALFOUR OPERATION

The right side of the jaw and chin had been drawn over toward the left side with marked asymmetry of the face, and the remaining lower teeth were drawn inward and backward. It was possible by traction to pull the main segment of the mandible forward and to the right into fairly good relationship and fix it in position by means of metal splints fastening the upper and lower teeth together. These splints were made by Dr. E. F. Axt, of the University of Pennsylvania School of Dentistry, who specializes in this work. The small ramus fragment on the left side was left free without splinting. On December 9, 1927, nearly nine weeks ago, by an incision beneath the left side of the jaw, the ends of the mandibular fragments were exposed and freshened, and a gap three inches long found between them. A bone graft from the crest of the right ilium was placed in the defect, in good contact with each fragment, and fastened in place with fine brass wire sutures passed through holes drilled in the bone. The wound healed without trouble. At the end of twelve weeks the splints will be unlocked, and it is expected that union will have taken place. It will then be possible to insert artificial dentures to supply missing teeth, restoring function of mastication and also improving the appearance of the patient.

Of all sources of bone graft for defects of the mandible, the crest of the ilium has been most satisfactory in at least twenty-five cases.

Dr. GEORGE SEMKEN, of New York, remarked upon plastics after removal of extensive cases of cancer of the mouth and chin and after severe burn cases. He believes the ideal method is to use a sliding flap because the blood supply is preserved and oedema avoided. Another advantage is that instead of having four sides of scar tissue there are only three and the fourth is for future growth. This is important in young patients, because in a child a square of scar tissue remains unchanged throughout life, and as the skin grows about it, it will cause the flap to raise and puff out. It is important to place these flaps behind the line of motion, so that they do not interfere with motion and will not produce a keloid growth. Doctor Semken has tried to systematize a procedure whereby with one operation, the case can be completed. This is not possible in such severe cases. Where possible in work of this kind, the grafts are taken from the skin of the anterior chest which is almost like that of the neck and face in character and will not grow hairs and on which large sebaceous follicles will not appear, and which is more nearly like what the patient has lost. If the arm can be raised to the head the pedicle is brought to the face and the blood supply remains intact, this is more difficult with a long pedicle, because the longer the pedicle the less liable it is that the blood will go through. It is desirable to have the flap placed behind the line of motion. Dental prostheses have proved of great assistance in securing better results in these cases.

Regarding the bone graft in the second case the speaker has been impressed at the ease with which a transplanted bone graft will heal and functionate. It is not so difficult to produce fixation but to produce it where the bone has been destroyed.

GASTRIC ULCER—BALFOUR OPERATION

Dr. JOHN H. JOYSON presented three patients operated upon for gastric ulcer by the Balfour method: cauterization, excision of the ulcer and posterior

gastro-enterostomy He also made brief reports of three other cases treated by the same operative technic The present drift of surgical opinion is decided toward a partial gastrectomy in the treatment of gastric ulcer He did not wish to be understood as advocating the Balfour method as a general substitute for partial gastrectomy The problem was a different one from that of duodenal ulcer, and he believed that Philadelphia surgeons were, as a rule, satisfied with the conservative measures in the treatment of ulcer of the duodenum His own limited experience coincided with that of surgeons like Moynihan and Balfour, who, working in large clinics with abundant material, observed satisfactory results following gastro-enterostomy for duodenal ulcer, with cures in 85 per cent of their cases, and either with or without direct attack upon the ulcer itself While subtotal gastrectomy has been advocated and extensively practiced in Europe for both gastric and duodenal ulcer, there is, as Balfour says, a wave of reaction against the sacrifice of large areas of a healthy organ as an indirect attack upon a benign lesion not situated in the stomach itself This in spite of the fact that the mortality of partial gastrectomy is admittedly low in experienced hands

With gastric ulcer the case is different It must be remembered, as Moynihan has emphasized, that one is dealing with a much rarer lesion The percentage of recurrences after conservative methods has been high These include simple excision of the ulcer, a posterior gastro-enterostomy, and a combination of the two, using knife or cautery to remove the ulcer Sleeve resection he would reject A few undoubtedly recover after gastro-enterostomy alone, excision alone is probably less beneficial A combination of the two, and use of the cautery for excision, is superior in its results to either alone The cautery should not be used for puncture only in accessible ulcers, but should be used as a cautery knife to remove the ulcer and its inflamed edges as well The greatest indication for its use as a substitute for gastrectomy which is the operation of election in the majority of cases, would seem to be in those ulcers on the posterior wall and lesser curvature close to the œsophagus, where gastrectomy would be difficult, and where oftentimes the portion of stomach remaining would be exceedingly small In such cases the radical operation partakes of the nature of a total gastrectomy, and trial of less radical measures certainly seems justified On the other hand, small accessible lesions, easily mobilized, are considered by Balfour himself as favorable instances for the same treatment, by excision and gastro-enterostomy Doctor Jopson was familiar with the objections urged against conservative treatment by Lewisohn and others and with the mortality statistics in which the deaths ranged from 1½ per cent to 7 per cent after subtotal gastrectomy, but he thought that it would be a good deal higher in the hands of surgeons whose experience in this field was not as large

Of the three cases shown, all males, one was well after one year, and one after two years The latter was a bleeding case, was transfused before operation, and had a subacute perforation on the posterior wall During convalescence, the abdominal wound reopened because of deficient healing power, due to the patient's poor condition pre-operative It was successfully closed by the technic of Shipley of Baltimore The third case, first operated upon four and one-half years ago, relapsed, and was again operated upon in October, 1927 The ulcer was then very large greatly indurated, on the lesser curvature, and close to the œsophagus Sections removed by the cautery showed it to be nonmalignant It was sutured with difficulty, and an enterostomy established for post-operative feeding He has done well since, after a course of treatment by the Sippy method, and at present is in fair health, without gastric symptoms, so long as he adheres to a simple diet

GASTRIC ULCER—BALFOUR OPERATION

Two other cases are well. One, a woman had a cholecystectomy at the same time the stomach was operated upon. A sixth case, also a woman reported as working most of the time and with some symptoms, controlled by diet. She also was a transfusion case, had a decided tendency to hour-glass contraction at the time of operation and today would be treated by gastrectomy and not by the conservative operation, if her condition permitted.

DR RICHARD LEWISOHN, of New York, said that his experience at Mt Sinai Hospital, has gradually forced him to adopt more radical procedures after having tried all the conservative methods, because the conservative methods were not satisfactory. He did local excisions a great many years ago and got recurrences, he did them without gastro-enterostomy and with gastro-enterostomy and found that the results were equally bad. He then tried sleeve resections and did not obtain very good results either. A large percentage of cases got hour-glass formation of the stomach and came back with recurrence of symptoms. Thus he was forced to adopt partial or subtotal gastrectomy for gastric ulcers and has been highly pleased with the results.

Local excision does not change the acidity of the stomach, and the patient still has the same underlying cause. The cautery method is based on the assumption that an acute perforation causes a cure of the gastric or duodenal ulcer. The speaker's statistics on that point indicate that suture of an acute perforated gastric or duodenal ulcer with or without gastro-enterostomy fails to cure the patient in 39 per cent of the cases, in other words nearly half of the patients were not cured and still had ulcer symptoms. Partial gastrectomy not only removes the ulcer, but the ulcer-bearing area with the accompanying gastritis and while the results from partial gastrectomy for duodenal ulcer have not been 100 per cent, Doctor Lewisohn is willing to state that in gastric ulcers they have been perfect. The procedure is not difficult if confined to those ulcers which are situated near the reentrant angle, in the very high ulcers, at the cardia, it is wise to be conservative, because a total gastrectomy is certainly a very serious operation and not often attempted. Partial gastrectomy does not remove a normal organ, but a diseased organ and does something for the patient which no other method can do, *ie*, it establishes post-operative achlorhydria, which seems to be the best means to prevent the recurrence of the ulcer. Doctor Lewisohn demonstrated lantern slides of a very interesting case, illustrating the life cycle of an ulcer. This patient was explored in 1922 for a large gastric ulcer, located right at the cardia. It was thought that the ulcer was carcinomatous and inoperable and nothing was done. The slides show that between 1922 and 1925 the ulcer disappeared. X-ray pictures taken in February, 1927, show a recurrence of the ulcer. Rontgenograms taken six months later show no evidence of an ulcer. Had gastro-enterostomy been done on him or if he had been subjected to a Sippy diet, one would have thought that surgical or medical treatment effected the temporary cure.

DR A O WHIPPLE, of New York, said that he had observed five patients in the Presbyterian Hospital in New York, who illustrate a point

which he thinks should be borne in mind, *i e*, too much credit should not be given to any one particular form of therapy for a lesion in which several forms of therapy give good results. In these five patients it was thought for one reason or another that it would be unwise to operate. They all showed definite penetrating ulcers in the lesser curvature, some were high and some were slightly lower. They were placed under treatment, in two cases very thorough medical treatment and in the other three cases very spasmodic treat-

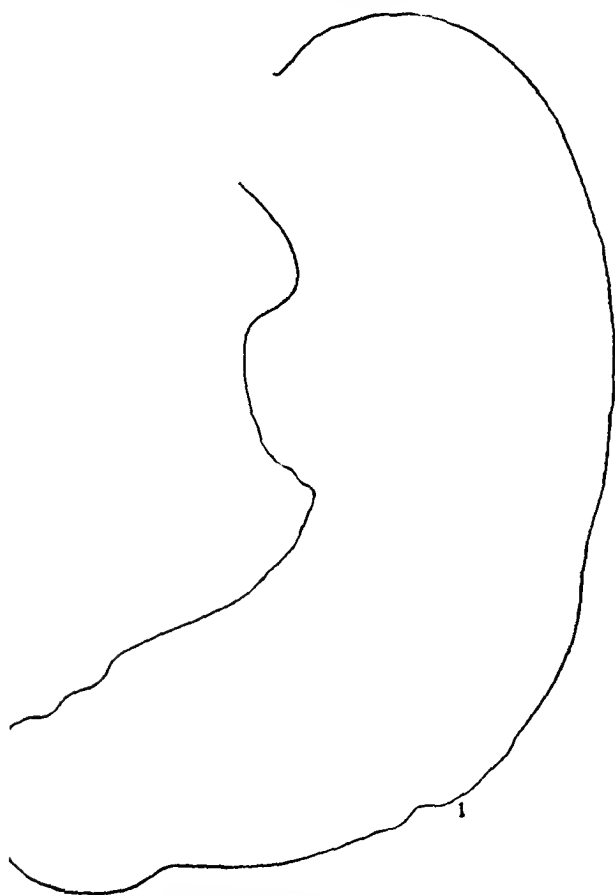


FIG 1.—Serial tracing of an ulcer of the lesser curvature, treated by rest in bed

ment—and in all five cases the ulcers disappeared. Three of the cases later came to the post-mortem table—this does not mean that they died from the ulcers—one patient committed suicide because of financial losses, another died in a Sanatorium for the insane, and a third died of carcinoma of the bronchus. The other two patients have apparently remained symptom-free. In the three cases which came to post-mortem, one showed complete healing of the ulcer, nothing remained of the previous lesion, in another there was a definite defect in the mucosa which undoubtedly if it had been watched for some time might have showed what Doctor Lewisohn has shown.

The speaker has not had a very wide experience with the

Balfour method but has had some remarkably good results in five out of eight cases. One case which has been operated upon by the Balfour method without gastro-enterostomy is free from symptoms after six years, on the other hand, three out of the eight cases have not shown good results, two have been reoperated and subtotal gastrectomy performed. Two cases had previously had gastro-enterostomy. The speaker regards the operation as a valuable procedure in the cases which do not lend themselves to a subtotal gastrectomy after a thorough course of medical treatment. If an exploratory operation is done and removal is attempted, Doctor Whipple believes that subtotal gastrectomy gives a better result than the cautery method. If the ulcer is high or massive, the cautery method is an excellent procedure.

DR FREDERICK BANCROFT, of New York, said that he had seen several cases diagnosed by Dr L G Cole at the Fifth Avenue Hospital, where there has been

GASTRIC ULCER—BALFOUR OPERATION

a large lesser curvature ulcer. Doctor Cole advises putting these patients in bed without any specific dietary treatment, and they are X-rayed every three days. It is interesting to note the way these ulcers repair. There is a gradual ingrowth from the edges of the ulcer, producing a type of constriction (See Fig. 2.) After this constriction occurs, repair proceeds by diminishing the depth of the ulcer. From the study of these cases we have formed a precept that if there is no diminution in the size of the ulcer after three weeks' rest in bed it becomes surgical. In six out of seven cases so observed, healing is shown by the X-ray to have occurred within four weeks' time by rest in bed and medical treatment.

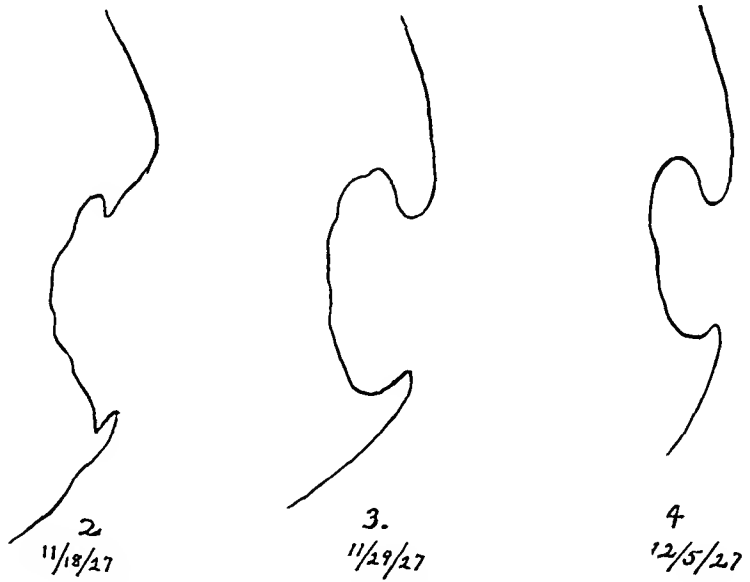


FIG. 2—Serial tracings of an ulcer of the lesser curvature, treated by rest in bed

DR JOHN H. GIBBON recalled that two years ago before the joint meeting of these societies, he presented a man upon whom he had performed a gastro-jejunostomy some years before and who had had subsequent bleeding. At that time Doctor Gibbon thought that the patient had a jejunal ulcer. No jejunal ulcer was found, the old duodenal ulcer had apparently healed. Pylorotomy was done at the time. Doctor Lewisohn said that the patient would not be well, he thought, until a subtotal gastrectomy had been done. Today the patient

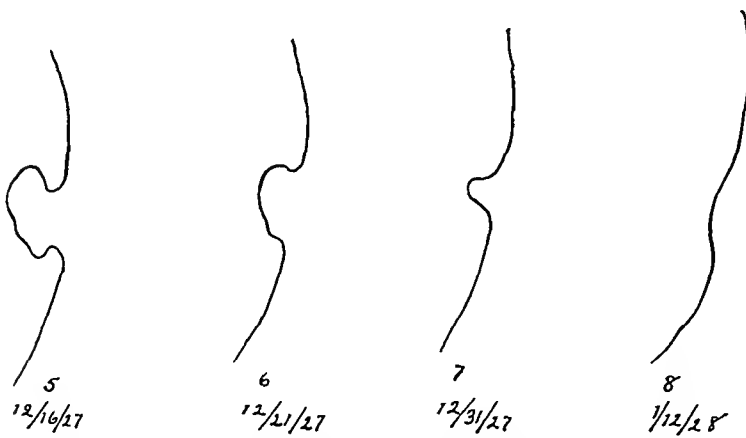


FIG. 3—Serial tracings of an ulcer of the lesser curvature, treated by rest in bed

is perfectly well. He had no medical treatment. With Doctor Whipple, the speaker agrees that it is a mistake to try to have one operation to cure many things. Subtotal gastrectomy is the best procedure in gastric ulcer but there are cases where smaller ulcers can best be excised by the cautery.

DR JOHN H. JOPSON said that if these cases are so diseased, as Doctor Lewisohn says, it is remarkable that they can do so well without treatment of any sort. There were two more patients in this series, who were unable to be here, one a woman operated upon in 1926, and another, a man operated upon by this method who later returned with recurrence of symptoms, he

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was given bicarbonate of soda and cascara and is at present symptom-free. One other patient had had an ulcer for fifteen years and now has hour-glass constriction of the stomach and should have a partial gastrectomy.

SURGERY OF THE PITUITARY LESION

DR CHARLES H. FRAZIER read a paper with the above title for which see p. 1.

CLEFT LIP AND CLEFT PALATE

DR WARREN B. DAVIS gave a résumé of 425 cases which he has recently reported in detail for which see the *ANNALS OF SURGERY*, vol. LXXVII, p. 386.

DR F. S. MATHEWS, of New York, said that the presentation of these cases showed the wisdom of having harelip and cleft palate cases operated on by specialists. The number of cases throughout the country is not sufficient to give all surgeons an adequate training and it is much better that one or two surgeons in each city should give special attention to the subject. The bearing of heredity in the etiology has received much confirmation. Davenport, in his "Heredity and Eugenics" illustrates this with a number of family trees. That the cause is inherited, is practically demonstrated by a number of cases where identical twins have shown the same defect. Ritchie and Davis have advised a change of nomenclature which involves abandoning the old name of harelip. It is in the interest of clearness of description to speak of cleft lip, cleft alveolus and cleft palate qualifying these terms by the adjectives complete or incomplete and unilateral or bilateral. The cleft in the alveolus is the matter of first importance and where the alveolus is cleft, it makes it advisable to close the lip, not because of the importance of the lip in itself, but because the closure of the lip aids so much in moulding the alveolus and in closing or narrowing the entire length of the palate cleft. Doctor Mathews has used a wire suture in the alveolus to narrow the cleft there as much as possible, closing the lip at the same time to increase the effect of the alveolar suture. Following Moorehead, of Chicago, he has spent ten or fifteen minutes in digital manipulation of the alveolus immediately preceding the operation in very young infants. He has several times operated on the lip and alveolus in children only two days old. When they are two or three weeks old, they have usually lost more weight than normal children. In former years when he saw one of these children underweight and with sub-normal temperature, it was his custom to send them to the pediatric division of the hospital to improve their nutrition before operation. This never worked. They always ran down and they often died with intercurrent affections. Now he sends them home with the advice to build up their general condition and then bring them back to the hospital. He was glad not to hear any recommendation of Brophy or Lane methods. He thinks they have had their day. He believed the point emphasized by Brophy that these clefts are not associated by any deficiency of tissue is incorrect. In some cases, he thinks the lack is considerable. This is rather conspicuous in cases of bilateral cleft lip. When all the tissue available in the palate is used, we often have a

thin palate and one far too short to close off the pharynx. Lane's method has been abandoned pretty generally because of poor speech results. The thing to be kept prominently in mind in treating these cases is to so reconstruct the alveolus that chewing and nasal breathing will be possible and thus by establishing function, favor normal growth.

DR FENWICK BEEKMAN, of New York, said that on the service of Dr Carl Burdick, at Bellevue Hospital, they have gone through the many stages of operative procedures on harelips and cleft palates and have finally come to the conclusion that the type of operation which they now do and which is similar to that described by Doctor Davis, is the one which gives the best result. Without any doubt the time to operate is when the child is young for at this time of life the alveolus can be moulded. The alveolus in those individuals with single clefts usually has the normal curve in the side of the cleft. The other side has a curve which is less acute than normal and consequently the end of the cleft on this side of the alveolus is far in front of that of the other. This can be corrected by moulding it to the proper curve.

Brophy's operation by narrowing the palate did not overcome this deformity. For several years the speaker has been moulding the alveolus and holding it in place by passing a silver wire far back above the alveolus and around through the frenum of the lip, thereby holding the moulded alveolus in place. The lip is immediately repaired. The wire is removed in twenty days. The importance of early operation, that is at the time when the alveolus can be moulded, was demonstrated recently by a child with a large cleft in his alveolus, five years of age. In this case the alveolus could not be moulded and had to be fractured, wiring the fragments in to proper position. We have had the same experience as Doctor Mathews has had. A large number of the infants sent to the pediatric service having died from pneumonia.

DR GEORGE M. DORRANCE said that he had had over 1000 reports abstracted and had gone over each and every one of them, all the operations in question are described three to five times. In the particular operation which Doctor Davis describes, the first part is after the method of Dieffenbach, and the second part after the method of Buhl. Many authors make the statement that they have used a particular operation in the past but have given it up. Very few say why they have given it up, with the exception of Passabaum who definitely states that if the soft palate is not long enough to touch the posterior wall of the pharynx when sewed together, then the operation is a failure and it would have been better never to have touched the palate, but to let a dentist put in an appliance which would have given a better result than a faulty operation. Concerning these cases with a short palate, Doctor Dorrance had seen three cases in one day where the palate was normal but could not touch the posterior wall of the pharynx. In such cases the speaker frees the palate all the way around to the alveolar margin and cuts the tensor palati muscle, allowing the constrictor muscle to pull the palate back. This leaves a hole in the front part of the palate which can be closed with a plate. But these cases can speak

DR ADDINELL HEWSON said that from an anatomical viewpoint if the process is broken so as to allow the tensor palati muscle to act in a straight line, it will have a tendency to bring the soft palate back toward the pharyngeal wall. It does another thing by relieving the ligaments to which are attached the superior constrictor of the pharynx and the buccinator muscle. The pterygo-mandibular ligament being freed from the sphenoid allows the lateral wall of the pharynx to come forward. It also allows the tensor palati muscle to bring the soft palate back toward the pharyngeal wall. Under these circumstances it would appear that the outline Doctor Davis has given should help materially in bringing the palate and pharyngeal wall together.

DR WARREN B. DAVIS said regarding the choice of time for operation, that it should be done as soon as the child's condition warrants, from ten days to three or four months. The speaker has been doing these operations since 1914, and certainly the best articulation is in those cases in which the operations on the lip, alveolus and palate were completed before the child was two years old.

COMPLETE URINARY RETENTION IN A CHILD, NECESSITATING
CYSTOTOMY, EXCISION OF VESICAL ORIFICE OBSTRUCTION,
NEPHROURETERECTOMY AND RESECTION OF BLADDER

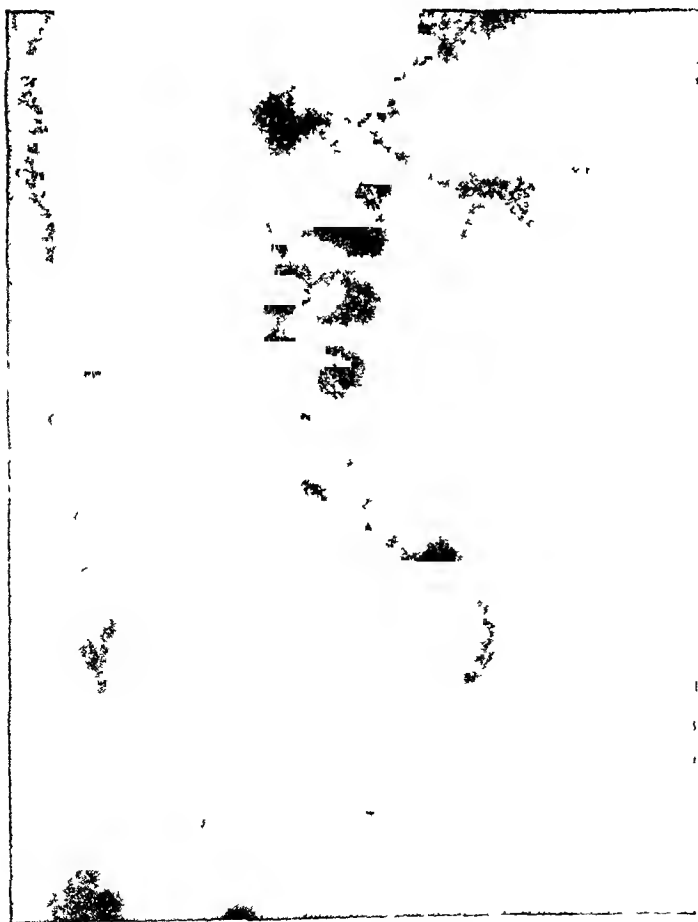


FIG 1—Urogram displaying large hydronephrosis and hydroureter, also dilated bladder

DR B. A. THOMAS reported the case of a male child, aged two years and ten months, who was admitted to the service of Dr. Charles A. Fife at the Presbyterian Hospital, October 13, 1927, and transferred to the genito-urinary service four days later. The case demonstrates extensive pathology, which is not infrequently found in children with urological lesions. The importance and feasibility of a complete urological investigation, and the successful result following rather extensive surgical intervention. During the past three months two other cases of complete retention of urine in infants had come under the speaker's care, one a two and a half weeks old female at the Babies' Hospital, in which the retention was the result of pressure from a

URINARY RETENTION IN A CHILD

greatly distended vagina, due to an imperforate hymen, the other a male six hours old requiring external urethrotomy, at the Graduate Hospital of the University for a congenital stricture or impassable obstruction of the urethra.

The case under report was brought to the out-patient department of the hospital because of inability to urinate. The previous medical history was negative, the birth being a twelve-hour non-instrumental labor first pregnancy at full term. The family and social histories were also negative.

For two weeks prior to admission the child had some frequency of urination, associated with constipation, requiring milk of magnesia to insure a bowel movement. A week later the urinary difficulty became marked and the child passed no urine at all for two days previous to admission. Stools were possible only with enemas. There had been no vomiting but appetite had been poor for a week or two and the child was languid. A slight fever had existed for five days. The child had not complained of pain but stooped over when he had a desire to urinate. He had lost some weight and on admission weighed not quite twenty-nine pounds.

On admission temperature was $101\frac{1}{5}^{\circ}\text{F}$, pulse, 128, respirations, 36. The child although well nourished and developed had a strained expression on his face. He constantly bent his trunk and held his lower abdomen, as though he were in

great discomfort. The head, ears, nose, eyes and mouth were negative, except for pallor of skin, mucous membranes and hypertrophied tonsils. There was slight adenopathy of postcervical lymph-nodes. Lungs and heart were normal. Abdomen was distended and tympanic and bladder dulness extended upward to umbilicus. No masses or enlarged organs were palpable. Peristalsis was present. Extremities and reflexes were normal.

Urination was impossible without catheterization, and that was successful



FIG 2 —Hydronephrotic deformed kidney and hydronephrotic removed at second operation

only with a metal catheter, evacuating a cloudy urine, loaded with pus and bacteria, otherwise negative

Bacteriological examination revealed staphylococcus aureus in pure culture at first, later mixed with the colon bacillus. Tubercle bacilli negative. Blood count: Reds 3,710,000, whites 10,250, hæmoglobin 70 per cent, small lymphocytes 24, large lymphocytes 7, polymorphonuclears 63, basophils 1, transitionals 1, eosinophils 4. Wassermann, negative. Blood urea nitrogen 17 mgms per 100 c c.

Chromoureteroscopy and ureteral catheterization were done October 19. The bladder mucosa was found to be greatly inflamed, œdematous, very red and covered with flakes of inflammatory exudate. In the region of the right ureteral orifice there was a large opening very suggestive of a diverticulum, but later determined to be the opening of a greatly dilated ureter. Indigocarmine, intravenously, appeared from the left normal ureter in twelve minutes, none appeared from the large opening on the right side. Both sides were catheterized: the urine from the left side was normal and sterile, that from the right contained thirty-five to forty pus cells to the field and culturally demonstrated the colon bacillus and staphylococcus aureus. The most

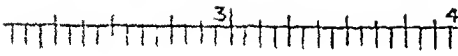


FIG. 3.—Stump on lower end of ureter removed at third operation

conspicuous abnormal condition in the bladder was a marked protrusion of the whole vesical mucosa on the right side below the large ureteral orifice, the same infringing on the bladder outlet, which presented a ballooning at the trigonal apex.

Urography was done two days later displaying the remarkable pyelo-uretero-cystogram shown in Fig. 1, defining a hydronephrotic kidney, a greatly dilated and kinked ureter and a much over-stretched bladder.

For ten days the child had not voided a drop normally, catheterizations were intolerable and had become a battle royal daily, urinary fever was becoming worse and the child more toxic. October 26 suprapubic cystotomy was performed and the bar or tissue obstruction at the neck of the bladder was removed by punch. The protruding or elevated floor of the bladder, in which the enlarged right ureteral orifice was situated, was definitely determined to encroach upon the vesical outlet. The usual pathology of a ureterocele could not be determined, it seemed that the whole mucosa of the right side of the trigone was flabby and greatly redundant and moved down upon the bladder sphincter, causing obstruction of the outlet. The rectum was found to contain about a handful of very hard feces (enteroliths). These were removed and the operation concluded.

The child made a very satisfactory recovery, picked up greatly in weight and strength and two weeks later, November 9, a nephro-ureterectomy was performed (See Fig. 2).

The gross specimen as described by Dr. John Eiman is as follows: "Specimen consists of a kidney and ureter. The pelvis of the kidney and the ureter are tremendously distended. The diameter of the ureter varies from 3.8 to 4 cm. It is kinked on itself so that it has assumed a sigmoid shape. The walls are a fraction of a millimeter thick. The pelvis of the

URINARY RETENTION IN A CHILD

l kidney measures roughly $9 \times 6.3 \times 6$ cm. The wall is paper thin. The kidney measures $7.8 \times 2 \times 3.8$ cm. Some fat is adherent to the capsule. The kidney is smooth and glistening and purplish-red in color. Over the distended ureter and pelvis is seen a network of large and small purplish veins. The kidney, pelvis and ureter measure $19 \times 10.5 \times 6$ cm in their greatest dimensions. Contents of ureter and distended pelvis, clear straw colored urine. Specimen preserved intact.

During the operation the child's pulse most of the time was uncountable, and following the operation his temperature reached 105 , but again he made a very satisfactory recovery. He was given all the time necessary to regain his health and strength before his next operation. During this time his bladder



FIG. 4.—Abdominal incision closed three weeks after final operation.

was drained suprapubically by a catheter, realizing that if the urine was not deviated in this manner, he would probably be unable to void because of the existing vesical pathology. However on December 21, his final and most serious operation, mainly removal of the lower end of the greatly dilated ureter with resection of the bladder, was performed as follows. As in the preceding operations, the anæsthetic was ether. The scar of the former suprapubic cystotomy was excised. The bladder was dissected free from the scar tissue of the former wound and mobilized, and the fistula enlarged. The right ureteral orifice about the size of the little finger tip was seen to be surrounded by redundant and very relaxed bladder wall, permitting bulging in the direction of the vesical outlet, which was obstructed, not allowing of the introduction of the tip of the little finger, and seemed to present a fibrous bar at the trigonal apex. This was removed with the punch. Marked granulations on either side of the vesical orifice were removed with the electrocautery. After packing the ureteral stump and bladder with gauze, they were freely mobilized. The bladder was then incised posteriorly and the ureteral stump removed by block resection of the adjacent portion of the bladder through all its coats. The posterior incision was closed by a Connell suture. The anterior incision by a running over and over suture about a large rubber tube. Another rubber tube, inserted on the right side of the bladder drained the resected area. The abdominal wound was closed in layers. The ureteral stump is shown in Fig. 3. Although the child's pulse was countless most of the time during the operation and his temperature reached $105 \frac{3}{5}^{\circ}$ afterward, he nevertheless passed through a most satisfactory convalescence. Three weeks later the child began to void naturally. January 21, the suprapubic wound closed permanently and sounds Nos. 10, 12 and 14 F. passed

easily through the urethra into the bladder. The child's condition today as shown by photographs (Figs 4 and 5), and weight curve (Fig 6), is normal, except for a few pus cells in his urine and he is about to leave the hospital.

Comment—There is no evidence to prove that this is a case of true ureterocele, caused by prolapse of the ureteral mucosa or of the entire lower end of the ureter into the bladder. Indeed, if so, it is certainly very atypical.



FIG 5.—Lumbar incision prior to discharge from hospital

In fact, congenital insufficiency of the ureteral orifice or regurgitant ureter, associated with an anomalous condition of the trigone and obstruction of the vesical orifice, could explain the pathology better. The thought of extensive congenital malformation is further borne out by the deformed remnant of renal tissue surmounting the hydronephrotic sac.

DR H. BECKMAN DELATOUR, of New York, said that this is a rare and unusual condition which he had never seen before. This case shows the importance of not being satisfied that one pathologic condition covers the entire case. Had Doctor Thomas simply removed the ureter and kidney and made no

further attempt at investigation, the patient would probably have dragged along for a time without the suprapubic wound healing and probably if at a later date the subsequent operation had been performed, the removal of the obstruction to the ureter would not have been so easily or so successfully carried out.

DR EDWIN BEER, of New York, remarked that many of these cases of children with obstruction to the outflow of urine due to disturbances at the neck of the bladder are not recognized until examination discloses a large globular mass in the hypogastrium associated with residual urine. If undetected, these cases pass gradually into uremia, and are then thought to be cases of chronic nephritis. If infection complicates the picture, many of these cases are diagnosed as cystopyelitis.

In the case presented Doctor Thomas states there was pyuria and twenty ounces of residual urine, which can only be explained by an obstruction somewhere between the bladder and the external urinary meatus. Most of these cases occur in males. Usually the back pressure leads to a bilateral hydro-

GASTROSTOMY IN CARCINOMA OF THE ŒSOPHAGUS

ureteronephrosis, and cystograms which show the reflux up both ureters are diagnostic of the condition when it is well advanced. Cystoscopy is particularly valuable in these children, and is always indicated in cases of persistent pyuria in infancy. About five years ago, three of these cases were reported by Doctor Beer in which excision of the posterior lip of the neck of the bladder, where the obstruction to the outflow of urine happened to be, led to complete relief of symptoms and cure of the patient.

In connection with some of these cases of unilateral megalo-ureter and hydronephrosis the question arises, is this due to back pressure, as in the case

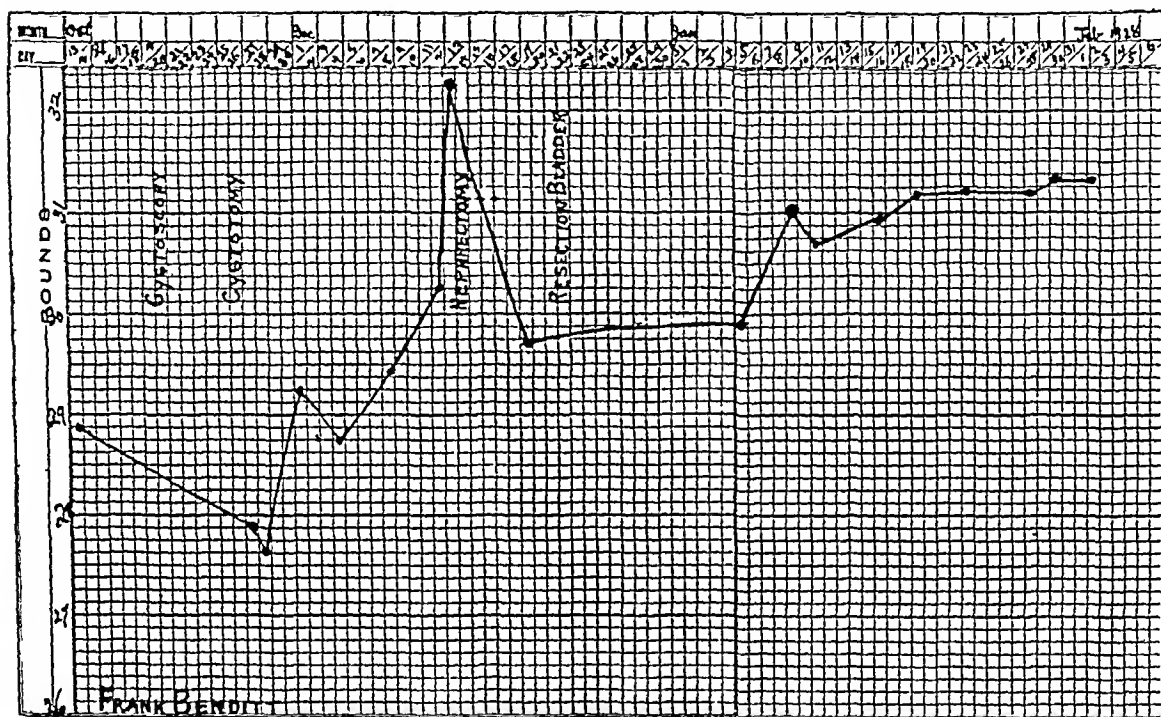


FIG 6—Weight curve from time of admission until discharged from hospital

reported, or is it caused by a congenital disturbance in the anatomical development of the ureter and its orifice in the bladder. Some of these cases present in adult life, and it is difficult to decide the origin of the megalo-ureter. It must be borne in mind that it is just possible that in some of these instances a ureteral stone, blocking the lower end of the ureter in infancy (as has been seen by Doctor Beer in the first three months of a baby's existence), may lead to a hydronephrosis, and when the stone is passed later on, this permanent megalo-ureter remains, and is only recognized in adult life when an operation is done for infection of this dilated tube. One is then liable to think he is dealing with a congenital deformity, while the condition is really a disease which originated in the early months or years of the patient's life through such a process as just outlined.

GASTROSTOMY IN CARCINOMA OF THE ŒSOPHAGUS

DR GEORGE P MULLER read a paper with the above title for which see p 48

DR WILLY MEYER, of New York, recalled a patient with malignant stricture of the œsophagus, who, after gastrostomy and forced feeding,

gained five pounds in one week. The type of operation he believes immaterial, though if Witzel's or Kader's method can be carried out, they will probably show best results. Gastrostomy is clearly indicated in these cases so long as radiologists cannot definitely prove that treatment by radium has brought about recovery. Here and there in various parts of the world there have been reports of cures by radium treatment, but definite proofs of œsophageal carcinoma having been cured by rays are still lacking.

The speaker thought that with thoracic surgery in its present status, surgeons should remain aggressive. What these patients need and are craving for, is the restoration of their power of swallowing. The principal aim of the surgeon should be the restoration of the patient's power to swallow. As long as radium has not proved definitely that, with the help of gastrostomy, it can cure, the radical operation remains indicated. Early diagnosis and early operation, of course are of greatest importance. The agencies which can help both the surgeon and the patient in this direction are the American Association for the Control of Cancer and the Gorgas Memorial. They are allowed to advertise in the newspapers and to distribute pamphlets. If they would say to these patients, "If you cannot swallow properly, your case is dangerous. Do not go to a dispensary, but go immediately to a hospital where X-ray examination and proper treatment are available," doubtless such propaganda would result in the patient's coming earlier under the care of the surgeon. It is the younger generation who will see a larger number of these cases at an earlier stage, and Doctor Meyer hopes that Doctor Muller will continue to do the radical operation in the hope of doing something definite for these patients. Three cases are on record that have lived after the radical operation. Doctor Torek's well-known case died of pneumonia eleven years after the operation.

Technically, the operation is not particularly difficult if one gets these patients in time. But when they come too late and when the important surrounding structures of the œsophagus are involved, one hesitates to do radical work.

It is in the hands of the surgeons now coming up, to see that resection of the œsophagus is not scrapped, but is continued. The speaker is convinced that if air-tight drainage of the pleural cavity is added to the operation, the number of recoveries will be greater than heretofore. On early diagnosis and early radical operation depends the future of the proper treatment of cancer of the œsophagus.

DR FRANZ TOREK, of New York, said that gastrostomy in carcinoma of the œsophagus may be done either as a preliminary to a subsequent operation or as an operation *per se*. As a preliminary to the radical removal of the carcinoma, of course its field is limited to the very early cases, and Doctor Meyer has gone into that so thoroughly that it needs no repetition. In regard to gastrostomy as an operation *per se*, it is a very unsatisfactory operation. The patients all die, some early and some late. Those who die late are the ones in whom the carcinoma of the œsophagus has not broken down and is

MORTALITY FACTORS IN ACUTE APPENDICITIS

more of a fibrous kind, while those who die early are usually the ones in whom the carcinoma has broken down, giving rise to bloody and foul discharge which practically poisons the patient. Regarding statistics, the speaker feels that if a person reports a number of cases that have lived for a long time after bouginage, you may be certain that it is in a series from an œsophagoscopic clinic, where a greater number of early cases are seen, whereas in many cases seen by the surgeon it would not be possible to pass a bougie at all. Such far advanced cases naturally are going to be operated upon by gastrostomy and will not live as long as the cases seen early in which bouginage is feasible. Theoretically, bouginage is about the worst thing possible for carcinoma of the œsophagus because instead of leaving it alone, the new growth is injured by being stretched and is thereby stimulated to more rapid development. Gastrostomy as an operation *per se* is done only in order to feed the patient and save him from starvation. No matter what the final result, gastrostomy relieves the patient for some time.

DR HOWARD LILIENTHAL, of New York, said that because he is the only person who has successfully resected the thoracic œsophagus without performing gastrostomy he is qualified for this discussion. The speaker drew attention to the method of relief by œsophagogastrostomy in cases in which exploratory operation has revealed inoperability, in carcinoma of the lower third of the œsophagus. The method was first published in Doctor Lilienthal's book called *Thoracic Surgery*—Saunders, 1925, volume 1, pages 361 to 370 and has since been described evidently independently by Sauerbruch in his second volume also published in 1925.

The procedure may be carried out extrapleurally by posterior mediastinotomy or intrapleurally. The fundus of the stomach is drawn upward through an incision in the diaphragm and a stoma is made between it and the upper section of the divided œsophagus, inverting the lower segment and leaving the inoperable carcinoma untouched. The speaker has performed this operation in but one case, unfortunately dead of pneumonia on the sixth day, but during those six days the patient was able to swallow normally soft solids without any leakage as was demonstrated at post-mortem examination. Those who are interested should look up the technic which is not difficult. The procedure is on the same physiological lines as gastro-enterostomy or ileocolostomy, performed in order to make a by-pass around an obstruction. If the pleura has been opened the phrenic nerve should be divided on the pericardium. If the pleura has not been violated the phrenic nerve should be avulsed through an incision in the neck.

MORTALITY FACTORS IN ACUTE APPENDICITIS

DR ELDRIDGE L. ELIASON read a paper with the above title for which see p 65.

DR MORRIS K. SMITH, of New York, said that in 337 cases of acute appendicitis operatively treated, there was a mortality of 4 per cent, thirteen deaths.

In reviewing these fatalities one is struck by the paramount necessity, now pretty well understood even by the laity, of early operation, if deaths are to be prevented. Abscess formation in appendicitis denotes an appreciable delay in bringing the patient to operation. In the seventy-seven cases in this series in which abscess was present the mortality was 10 per cent as opposed to 1.9 per cent in the remaining 260. Of the five individuals who died in the non-abscess group the duration of illness was given as one day, two days, four days, five days and two to three weeks respectively. The latter possibly should not be included. She presented an unusual type of thickened inflammatory reaction in appendix, cæcum and pelvis without free pus. Both of the apparently early cases, listed as of one and two days' duration were watched overnight before operation was undertaken. Perforation, gangrene or spreading peritonitis were found in all five. Early institution of operative treatment depends on early diagnosis. Doctor Elason has brought out some of its difficulties. The speaker believes it is better practice to take out an occasional normal appendix than to err on the side of procrastination in so treacherous a condition as appendicitis. Age is a factor in a higher mortality of the disease for one reason because of the added difficulties in diagnosis. Of the thirteen deaths, two occurred at the extremes of life. One was a child of three years who had been sick a week before her mother called a physician. She had an abscess filling the pelvis. The other was a woman of eighty with abscess who succumbed after a long illness.

If all patients could be operated upon within the first twenty-four hours of the attack, the mortality would be very low but the factor of high virulence of the infecting organism or lack of resistance on the part of the patient would still account for a few fatalities. A young man operated on the second day of his illness presented a perforated appendix and generalized peritonitis with no walling-off adhesions. He was dead two days later. Although earlier diagnosis and operation might have changed the outcome yet the whole impression was one of an irresistible rapidly progressing infection. A severe diabetic, who had at operation a retrocæcal abscess, developed a gas gangrene to which he rapidly succumbed. This is the only such complication in the speaker's series. Drainage, with little or no suturing, might have given a better result.

The factor of surgical judgment remains to be considered. It is trite to say that with a very sick patient the least possible should be done yet one is inclined to err in this regard. A girl with a large appendiceal abscess came to operation on the sixth day of her illness. She appeared toxic. The appendix was removed. She died twenty-four hours later. It is quite probable that had we been satisfied to drain alone the outcome would have been the same, yet it was poor judgment in this instance to subject the patient to the added trauma of the appendectomy. Doctor Smith's experience with enterostomy is slight, suffice to say that the one time when it was used the result was discouraging.

POST-OPERATIVE PULMONARY ATELECTASIS

CLOSURE OF THE PROSTATIC BED IN SUPRA-PUBIC PROSTATECTOMY

DR JOHN B DEEVER read a paper with the above title for which see p 118

DR JOHN E JENNINGS, of New York, said that there is no doubt that certain cases demanding prostatectomy can be operated upon early and can be done under spinal anæsthesia. When the preparation of the case has been very careful, spinal anæsthesia is a help. There are however some cases in which the heart will not stand any form of spinal anæsthesia, also, there are other cases which demand the two-stage procedure. With all due respect to Doctor Deaver, the speaker wished to say that supra-pubic prostatectomy as shown by his cuts, makes him wonder if Doctor Deaver has not been deceived by the "tactus eruditus" in believing that it is the open air work which he has described. As to the preparation of these cases much has been learned from careful study of the blood chlorides, and Doctor Jennings believes the restoration of normal chlorides is an important factor.

DR EDWIN BEER, of New York, stated that he could see no particular advantage in attempting to close the prostatic bed by suture of the mucous membrane of the bladder into the prostatic bed, if plain catgut were used, all these wounds being infected it would be absorbed long before adequate union between the suture surfaces could take place, and if chromic catgut were used, it might lead to calculus formation, and possibly in either case to stricture at the neck of the bladder. Attempts have been made by Doctor Beer to close the prostatic bed in this way, but as this is only feasible in a one-stage operation and had apparently no particular advantage except as a hæmostatic aid, he had given up this technical refinement.

DOCTOR BEER asked Doctor Deaver whether he had ever seen the result of such a suture at autopsy, and whether at that time or at subsequent reexamination by urethroscopy there was any evidence that the suture had held, or there was any difference in the appearance of the posterior urethra from that of unsutured cases.

POST-OPERATIVE PULMONARY ATELECTASIS

DRS WALTER ESTELL LEE, GABRIEL TUCKER and LOUIS CLERT read a paper on the above subject for which see p 6

DOCTOR ISADORE S RAVDIN read a paper entitled *The Production of Atelectasis*—based upon experimental work in which Drs Walter Estell Lee, Gabriel Tucker and E P Pendergrass participated, for which see p 15

DR HOWARD LILIENTHAL, of New York, said that the term massive atelectasis may be employed as a compromise. Atelectasis does not mean airlessness but signifies, etymologically, absence of terminal expansion. True atelectasis can be produced only if the chest is open or if there is something within the thorax which compresses the lung such as fluid, gas under tension or other direct pressure upon the lung.

When something causes the lung to contract in the *closed* chest the same force which produces the contraction causes a filling of the air vesicles by a

kind of suction, with fluid and cells different from the exudation of pneumonia and with greater opacity to X-rays. This has been a convincing demonstration of the phenomenon known as atelectasis by obstruction of a bronchus and how the removal of this obstruction can produce a return to the normal. The atelectasis or collapse just referred to, however, seems to be due to an actual contraction of the lung. It is probably produced by some nerve influence.

In two cases recently reported by Bergamini and Shepaud (*ANNALS OF SURGERY*, vol lxxxvi, No 1) the patients died of acute massive atelectasis and early autopsies were performed. One of these patients died on the table during the suturing of the wound in an abdominal operation. There was not time for a bronchial obstruction to have brought about the absorption of alveolar air and no obstruction was found post-mortem. Yet the pulmonary tissue on both sides with the exception of the extreme apices was solid like liver. The autopsy was performed by Doctor Symmers, at Bellevue. The diaphragm had risen as high as the fourth rib posteriorly evidently drawn up by spastic collapse of the lung with consequent increase of negative pressure.

In 1919, there appeared in the *Journal of the American Medical Association* an article which was prepared by Doctor Lilienthal for the Surgeon General of the Army, on Thoracic Injuries. It is a report of the Activities of Operating Team 39 in Evacuation Hospital No 8. In addition to the speaker the members of the team were Dr Walter M. Brickner and Dr W. A. Kellogg of New York. This report states: "Atelectasis has been frequently noted by operators and we have never reached a satisfactory explanation of it. It usually occurs in the neighborhood of the wound and is something more than collapse of the lung. It is usually unilobular, the lung being contracted to a very small size, no air being in it at all. The tissues are soft and not infiltrated. We would suggest that animal experiments be carried out."

An interesting case from the clinical standpoint was that of a young man operated upon for appendicitis by Dr Paul Livingston of East Orange, New Jersey. On the third post-operative day there was a sudden attack of coughing, bloody thick mucoid expectoration and fever which was diagnosed as a right lobar pneumonia. When seen by the speaker the physical signs suggested massive collapse and a roentgenogram revealed the classic picture the heart being drawn entirely into the right side so that the lateral processes of the vertebræ could be seen. Two days later the lungs were clear. This was probably a case of obstructive atelectasis.

The speaker believes that in a case of post-operative atelectasis, in which the symptoms are severe and threatening, early bronchoscopy should be performed in the hope that there might be a mucus plug which could be dislodged. Pol Coryllos and Binbaum (*Archives of Surgery* vol xvi, No 2) in a painstaking and scientific paper presented 112 cases of massive atelectasis gathered from many sources and they believe that the only cause of this condition is obstruction. Judging by his own experience and that of observers

TERATOMA OF THE MEDIASTINUM

like Bergamini and Shepard with their convincing post-mortem material, Doctor Lilienthal must disagree with this conclusion

He suggested that in the nomenclature of the conditions these three distinct varieties of atelectasis be made 1, obstructive, 2, compressive, 3, essential

TERATOMA OF THE MEDIASTINUM

DR JOHN H GIBBON presented a young colored man who had come to the Jefferson Hospital complaining of a swelling in the chest and shortness of breath. An X-ray diagnosis of mediastinal tumor with pleural effusion was made. The chest had been aspirated several times and Doctor Gibbon plans to operate upon the patient in the near future.

DR CARL EGGERS, of New York, said that benign tumor of the mediastinum is so rare that no one man has sufficient experience to warrant entering into a free discussion of the subject. One has to study each case individually and work out a plan of procedure, just as Doctor Gibbon has done in this case. What the pathology of the condition in this patient is has not been established, and probably will not be until operation. The fact that fluid has been withdrawn on two occasions suggests the possibility of trying to do the operation in two stages. At the first session one might cut a window into the chest wall and get some idea of the nature and extent of the lesion. The tumor might be marsupialized. Gradual evacuation would avoid the serious reaction which might follow removal of such a large mass in one stage, even if it were feasible. At a later date extirpation could be carried out. In the literature one finds numerous cases successfully handled in that way.

BRIEF COMMUNICATIONS

SQUAMOUS-CELL EPITHELIOMA OF THE THYROID GLAND

CASE—A married woman aged forty-seven came to the Mayo Clinic, December 14, 1927, because of goitre which she first noticed twenty-five years previously. For fifteen years there was little or no change in the size of her neck. During the last nine or ten years the goitre had grown gradually and during the seven weeks prior to her admission it had grown quite rapidly on the right side, causing pain in the right side of the



FIG 1—Squamous cell epithelioma of the thyroid gland

neck which radiated upward to the right ear. For two weeks she had noticed definite redness over the growth. Her general health had been good until two months previously when her appetite failed. She had lost twelve pounds. The family history was unimportant, to her knowledge, there had not been any malignancy. Her mother had had a goitre but it was not the cause of her death.

Examination—The patient was rather obese, five feet five inches in height, and weighed 155 pounds. The eyes were normal. The tonsils were enlarged. The vocal cords moved normally. The diffuse enlargement of the thyroid gland (7.5 by 6 cm.) was nodular on the right side and

extended into the posterior triangle. The skin over this area was quite red. The hæmoglobin was 68 per cent, erythrocytes number 4,560,000 and the leukocytes 8,800. The systolic blood pressure was 124, the diastolic 84. Röntgenograms of the chest were negative. The metabolic rate was +24.

A diagnosis of adenomatous (probably malignant) goitre with mild hyperthyroidism was made.

Operation—December 19, under local anæsthesia, a small transverse incision was made about 2.5 cm. above the clavicle. The right side of the gland appeared grossly to be malignant. Part of it was removed and a tube left in place for the use of radium. Microscopic examination showed the tissue to be squamous-cell epithelioma (Fig 1).

According to the literature squamous-cell epithelioma of the thyroid gland is rare. Roeder,* in 1921, made a complete review of the literature noting nine unquestionable cases. He gave an abstract of the cases and a complete

* Roeder, C. A. Squamous-cell Epithelioma of the Thyroid. *ANNALS OF SURGERY*, 1921, vol. LVIII, pp. 23-29.

COMPLETE DOUBLE UTERUS WITH SINGLE VAGINA

bibliography He also reported a case of his own, that of a woman aged sixty-two, who had had symptoms of substernal pressure for four months, accompanied by severe choking spells of two months duration He removed the large adenomatous thyroid, the left lobe of which appeared malignant grossly Microscopic examination showed squamous-cell epithelioma Radium applications were made and the patient did well for fourteen days when she died following a paroxysm of coughing Necropsy was not obtained

CLAUDE F DIXON, M D,
of Rochester, Minn
FROM THE MAYO CLINIC

PULMONARY EMBOLISM

To the Editor, ANNALS OF SURGERY

In the issue of the ANNALS OF SURGERY, April, 1928, Doctor Hall, on page 534, says

"Trendelenburg has successfully operated upon pulmonary embolism in animals, but as yet there is no authentic case of successful removal in the human"

Before the German Surgical Congress of 1924, M Kirschner presented a patient upon whom he had successfully operated for this otherwise lethal malady This was the first successful case

A W Meyer * presented at the 1927 meeting of the same society, a fine looking woman of fifty-four years, similarly rescued by him Meyer adds useful additional details of technic

* Archiv fuer Klinische Chirurgie, vol cxlviii

WELLER VANHOOK, M D,
of Chicago, Ill

COMPLETE DOUBLE UTERUS WITH SINGLE VAGINA

DOUBLE uterus *per se* is not a very rare condition However, only two cases like mine have been reported in the literature up until 1924 (see below)

Dambrin and Bernardbeig,¹ in 1924, made an elaborate report reviewing the literature of the various varieties of double uterus They found only two cases in which there were two distinct uteri, two distinct cervixes and only one vagina

It will, therefore, be seen that this particular type of anomaly, in which each uterus was distinct and separated from each other on either side of the medial line, each with its own cervix but with a single common vagina, is very rare and as I have recently met with a case of this kind which is given below, I think it worthwhile to place it on record In the recent literature I have found no exactly similar case In Macgown's² case there were two uteri, two cervixes and one vagina but this latter was divided by a fleshy septum with the clitoris and labiæ normal In Moench's³ case there were two uteri, two cervixes and one vagina, but the two cervixes were situated side by side and

BRIEF COMMUNICATIONS

united in the middle by a sagittally disposed fibrous band. In de Muylder's⁴ case there was one vagina and two uteri, but the latter were probably in communication at the internal os as there was only one cervix.

The clinical and pathologic aspects of the various types of double uterus have been exhaustively dealt with in the reports by Palmer Findley and Dambin and Bernardbeig already cited, also in a report by Guilleminet and Michon.⁵ Palmer Findley⁶ collected 132 cases of complete double uterus and

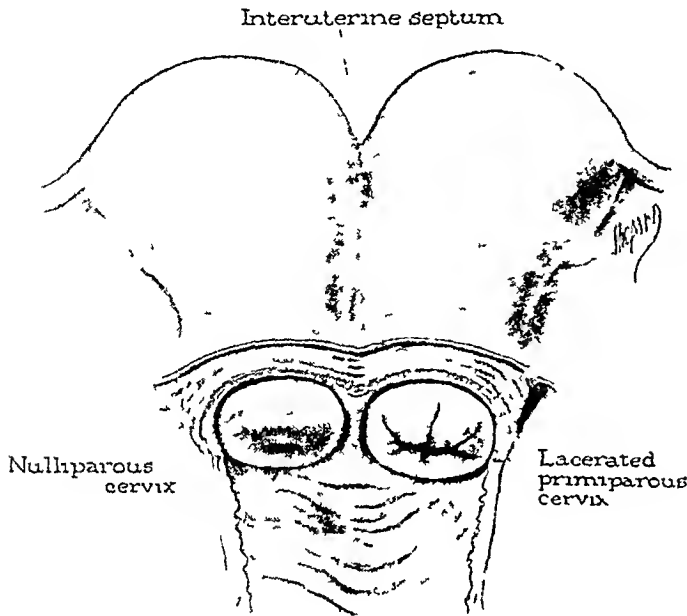


FIG 1—Appearance of uteri *in situ*

reported three cases of his own. In all these cases there was a complete doubling of uterus, cervix and vagina and every patient had been pregnant. It would be superfluous to reiterate them and I will merely confine myself to reporting the facts of my own case.

CASE—Mrs L S (Case No 33778), forty-one years old, female, white, housewife by occupation, was admitted to the American Hospital on November 3, 1927, and dismissed November 17, 1927.

History—Menstruation began at fourteen, twenty-eight day type, flows four days without inconvenience. Patient has been married twenty-one years. No miscarriages. Has one daughter born nineteen years ago, living and well, full term child, weighed 6½ pounds at birth, no difficulties at delivery, normal labor. Following delivery she was told she had "falling of the womb", and she felt the uterus descending and protruding from the vagina.

Patient had usual diseases of childhood, much trouble with teeth and had influenza and pleurisy. She has always been a sufferer from chronic dysmenorrhœa. Patient notices, in the standing position, that the uterus comes out of the vagina about two inches. The prolapse is so marked during the menstrual period that the uterus becomes adherent to the menstrual pad. During menstruation she has bearing down pains from the sacrum to the lower abdomen.

Physical Examination—Well-nourished female, not acutely ill. Temperature 98°, pulse 84 of strong quality and normal rhythm. Blood pressure, systolic 140, diastolic 94, respirations 20. Examination of head, neck and extremities negative. Examination of abdomen reveals a palpable spleen. The uterus is palpable through the abdominal wall as an irregularly outlined mass. Vaginal examination reveals the presence of two cervices (Fig 1), one of which is somewhat larger and presents a stellate laceration. Both cervices present at the introitus vaginæ.

Operation—Under ether narcosis, the abdomen was opened, by a median incision, and after packing the bowels out of the way, two distinct uteri presented. They were attached by a musculo-fibrous band at the uterocervical junction. Each uterus had one normally formed Fallopian tube and one ovary. Both fundi were of equal size and normal configuration. A supra-vaginal hysterectomy was done. After ablating the uteri two dis-

COMPLETE DOUBLE UTERUS WITH SINGLE VAGINA

inct cervical canals were visible. Plastic of the cervixes. They were then treated in the usual manner, peritonealized and attached to the anterior abdominal wall.

The abdomen was closed without drainage. Patient made an uneventful recovery, leaving the hospital fourteen days after the operation. Wound healing per primam.

Pathological Report—(Dr J. J. Moore)—The specimen is a double uterus, with both uteri opened exposing their endometrium—hardened in formalin—and amputated supracervically. Both uterine bodies are of about the same size, measuring 4 cm. long \times 3 cm. wide, with average thickness of walls about 2 cm. They are attached to the upper part of the cervix. The endometrium in both uteri is apparently about 1 mm. thick and blood-stained. Each uterus has a Fallopian tube attached, the ovary being included with one of the tubes. This tube is about 8 cm. long \times 0.5 cm. in diameter, and the attached ovary, which is fibrotic, measures 3 cm. \times 1 cm. \times 0.6 cm. The other tube is about 9 cm. long \times 0.5 cm. in diameter. Neither tube shows any definite pathological change, grossly.

Microscopic Examination—Sections show no essential differences in the endometrium and muscular wall of the two uteri.

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MAX THOREK, M.D.,
Chicago, Ill.

BOOK REVIEWS

GYNECOLOGY FOR STUDENTS AND PRACTITIONERS By THOMAS WATTS EDEN and CUTHBERT LOCKYER Third Edition New York The Macmillan Company, 1928

This is the third edition of the well known English text-book of gynecology by Eden and Lockyer. This is a work with which the writer is exceedingly familiar through five years of acquaintance as the preferred text in gynecology at New York University and Bellevue Medical School. The retention of Eden and Lockyer as the text-book of choice through these years, speaks of the attitude of the gynecological department toward this work as no review can do. The present edition retains the high standard of its predecessors. It has been brought abreast of modern gynecological thought by the inclusion of such topics as recent researches in relation to menstruation and the corpus luteum and the work of Sampson as well as a presentation of the blood sedimentation test in relation to gynecology.

It is not the intention of the writer to offer a detailed review of this work for this would entail rewriting this edition or offering another. This text has maintained its position because of an excellent presentation of the ground facts in our specialty without which a superstructure is impossible. Gynecological anatomy and physiology are clearly and ably presented. Considerable space is given to such subjects as the follicle theory of menstruation and the influence of the corpus luteum. The entire text is replete with excellent illustrations. The number and clarity of the microscopical plates is unusual. Many of these are in colors.

As is true in all works there are many personal opinions of the authors with which the writer differs. This is most often noted in a consideration of therapeutics where differences may arise without affecting what we have called the ground facts in gynecology. In the section devoted to gynecological diagnosis considerable space is rightly given to tubal insufflation with both gas and opaque substances. We were surprised to find an absence of any reference to Rubin's work in America in this field. In considering hemorrhage and radiation the text is too brief and in several places misleading, for example in considering menorrhagia prior to the menopause a dose of 2400 milligram hours is advised with the suggestion that this be repeated in six weeks if necessary. This is a much larger dose than we are accustomed to, nor do we at all agree that radiation is suitable only for benign conditions and that radical operation should be applied in malignancy.

In the consideration of gonorrhœa in women we cannot follow with the authors in their endorsement of intra-uterine applications in corporeal infection nor in their apparent complete acceptance of diathermy in this field.

From an American standpoint we feel it an error to include in a text on

BOOK REVIEWS

gynecology a consideration of such subjects as cystitis, pyelitis, acute appendicitis and diverticulitis. Is not this an unwarranted excursion into the fields of urology and general surgery?

The concluding portion of the text on operative gynecology is a valuable addition in which many of the more common operative procedures are well illustrated and described.

In conclusion the writer wishes to state that in his opinion this book occupies its present position because of its most able presentation of gynecological pathology. In many of our American texts there is an absence of this necessary foundation. Eden and Lockyer have ably correlated gynecological anatomy, physiology, and pathology presenting these ground factors, in our specialty, in a clear and concise manner with an abundance of microscopical as well as gross illustrations. The writer, for these reasons, considers this edition an excellent text-book for students, a good book for the occasional gynecologist to consult frequently, and a ready reference for the specialist.

FRIDERIC C HOLDEN

GYNECOLOGY By HOWARD A KELLY and Collaborators Pp 1012
D Appleton Co, New York

The author in chief has introduced into its text eighteen personal chapters representing those fields in which he has been so preeminently active and authoritative. The work bears no relation whatever to his earlier publication and has incorporated all of the late innovations in this science which have so greatly aided the specialist in the treatment of relevant conditions. Among these newer items are to be noted protein therapy, psychiatry and mental hygiene, ureteral stricture, endothermy, ultraviolet radiation, extra-uterine pregnancy, sterility, endocrinology and organotherapy.

In all, forty-nine chapters are found necessary to cover the subject. Both medical and surgical treatment are discussed in order to properly and exhaustively present the science of gynecology in all its ramifications by twenty-one collaborators, each particularly interested in the special field which he presents and whose preeminence in it particularly enhances the general value of the work.

The volume is adequately illustrated and the mere mention of the artists Max Broedel, Horn, Becker, Freret, etc., is proof enough of their excellence of execution. The colored plates are particularly informative.

JAMES TART PILCHER

PHYSICAL DIAGNOSIS By CHAS PHILLIPS EMERSON, A B, M D, Professor of Medicine, Indiana University School of Medicine. Octavo, 553 pages, 324 illustrations. Philadelphia & London, J B Lippincott Co, 1928.

Diagnosis having become mechanized, attempts to standardize the same were but a natural sequence of the successive laboratory and instrumental

BOOK REVIEWS

aids Thus a more "Scientific Medicine" was being acclaimed at the expense of the "Art of Medicine" based on the observance of Signs and Symptoms of Physical Diagnosis

The appearance of this volume of 553 pages and 324 wholly original illustrations is most welcome as harking back to those foundations upon which the Art of Medicine is built

One was wont to regard a work on Physical Diagnosis as covering particularly the signs and symptoms of Lung and Heart This treatise is vastly more comprehensive and replete in the narrative of physical signs peculiar to all exposed and hidden regions of the body wherefore it bids fair to be valuable alike to physician and surgeon, whose perusal thereof should greatly fortify one's failing sense of clinical medical and clinical surgical diagnosis, and heighten the appreciation of the medical student for time honored clinical teaching of physical methods which alone develop that prized attribute "Clinical Acumen," a *sine qua non* of the humblest practitioner of the Art of Medicine

Physical Diagnosis of the abdomen is every bit as complete as that of the thorax, and this chapter is worthy of the attention of the surgeon as is the latter of the internist

In short, recourse to the up-to-date methods of physical diagnosis are here rendered most admirably, and dependence on them must needs lead to good diagnoses Each paragraph is initiated with heavy type and the salient features thereof likewise treated The index of 20 pages printed in double column still further enhances the worth of this work

MARTIN W WARL

EDITORIAL ADDRESS

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MASSIVE (ATELECTATIC) COLLAPSE OF THE LUNG †

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Definition and Description —Massive collapse of the lung is a condition in which one or more lobes, previously well aerated, suddenly, without apparent cause, lose their air content and collapse. Sir John Rose Bradford¹ has defined the condition as "an unusual condition in which the lung, without the presence of any gross lesion, such as bronchial obstruction, pleural effusion, etc., interfering with the free entry of air, becomes airless to a greater or less degree." This condition is essentially an atelectasis and should not be confused with collapse of the lung incidental to pneumothorax, the two conditions have nothing in common.

In massive (atelectatic) collapse, the lung does not leave the chest wall. In its collapsed or atelectatic state the lung occupies a smaller space than it did when fully expanded. To compensate for the space lost from collapse of the lung, the chest wall is depressed, the trachea, heart and mediastinal structures are drawn over toward the involved side and the diaphragm is pulled upward. The loss of air content produces consolidation of the lung fully as dense as that of lobar pneumonia.

Radiographic Characteristics —The radiographic picture produced is most striking and quite characteristic. One entire side of the chest shows a dense, homogeneous consolidation. There is a definite narrowing of the chest cavity on the involved side, the ribs become more oblique and there is a decrease of the intercostal spaces. The trachea, heart and other mediastinal structures are displaced toward the involved side, the tracheal displacement is always evident, the heart may show varying degrees of displacement, ranging from slight to the extreme of being undetectable in the radiograph. The apex beat, normally present in the *left* mammillary line may be displaced to a position in the *right* mammillary line. Where the upper lobe alone is involved, displacement of the heart may be negligible and deviation of the trachea the only sign. Compensatory emphysema of the uninvolved side may be very marked.

Physical Signs —The physical signs associated with this condition after collapse is well established are likewise very striking. Inspection reveals a flattening and immobilization of one side of the chest. The respiratory function is carried on entirely by the other lung. The percussion note is flat over

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the entire side and auscultation fails to elicit normal vesicular breathing. The marked displacement of the trachea may give an erroneous impression of pneumonic consolidation.

During the preatelectatic state crepitant and sibilant râles may be heard over the collapsing lung. This was observed in Cases IV and VI of our series, but its significance was not understood at the time. Scott and Joelson² refer to such findings but over both lung fields.

The condition is most frequently encountered as a *post-operative complication of abdominal and rectal surgical procedures, especially following appendectomy and herniotomy*. Its occurrence is apparently independent of the anæsthetic used, cases being reported following all types of anæsthesia, even spinal anæsthesia, or when local anæsthesia was used. It occurs after fracture of the pelvis, or of the femur, and after injuries apparently trivial to the chest, abdomen or buttocks. The condition may result from post-diphtheritic paralysis of the diaphragm, or from diphtheria, poliomyelitis, or meningitis. It is usually unilateral, occurring most frequently on the same side as the trauma or operation. Numerous cases of contralateral involvement are reported (our Case III is an example). Two instances of bilateral atelectasis have been reported, one by Bergamini and Shepard³ following operation for uterine fibroid, and death occurred on the operating table. Autopsy revealed total atelectasis of both lungs. The second case was reported by Santee,⁴ as having followed septic abortion and apparently occurred in a physician's office.

Review of the Literature—This condition is by no means a recent observation. It was first reported as a definite clinical entity in 1890 by W. Pasteur,⁵ who described it as "massive collapse of the lung". His first observations were on thirty-four cases of post-diphtheritic paralysis of the diaphragm. In the Bradshaw Lecture⁶ in 1908, he discussed the nature of massive collapse of the lung as contrasted with the scattered lobular collapse that may occur when the bronchioles are obstructed by secretions, and the alveoli slowly emptied by absorption of their air into the circulating blood. He considered the cause of the collapse as due to paralysis of the diaphragm and other respiratory muscles, and suggested that reflex inhibition of the diaphragm might lead to similar results.

In 1914, he⁷ again called attention to the condition as a post-operative complication of abdominal cases, reporting sixteen such cases which had been encountered in two thousand abdominal operations. He also stated that he had seen a similar condition after injuries to the chest wall. The pathology in every instance was the same.

"Whenever—whether as a result of paralysis or of reflex inhibition of muscular action—the distending force acting on the lungs becomes less than that of the elastic and muscular agencies which tend to cause its contraction, the latter, so to speak, take charge with the result that the affected portion of the lung rapidly empties itself of its contained air."

The disturbance in the respiratory function may be due either to paralysis or reflex inhibition from inflammation or pain.

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In the same year, Elliott and Dingley⁸ reported eleven cases all of which had followed abdominal operations. After a complete analysis of their cases, these writers came to the conclusion that immobilization of the diaphragm and shallow respiratory movements allowed the bronchioles to become blocked with secretions, the circulating blood absorbing the residual alveolar air. They observed large amounts of mucopurulent sputum in all of their cases and concluded that atelectasis was a direct result of occlusion of the bronchi by this means.

Holmes⁹ cites four cases and refers to twelve others found by Bradshaw among 3,559 patients operated upon at the Middlesex Hospital from 1906 to 1910. These cases all developed among post-operative patients, especially after appendectomy and herniotomy.

Crymble¹⁰ reported fifteen cases after gunshot wounds which did not vary essentially from those resulting from abdominal operation.

In 1918 to 1920, Sir John Rose Bradford¹ made a complete study of the subject in connection with war wounds. He failed to find any postmortem evidence of bronchial obstruction, pleural effusion or other lesion which might interfere with the aeration of the lung, and concluded that, while it seemed incredible, the evidence would seem to indicate that a reflex spasm of the bronchioles was the cause of the obstruction. The condition was observed by him following injuries of the chest and trunk, after fractures of the pelvis or femur, and after gunshot wounds of the chest. He cites an instance where an apparently trivial wound of one side of the chest was followed by a collapse of the opposite lung, no anæsthetic having been administered, and no operative interference undertaken. Some injury, however, seemed to be present in all cases.

Briseoe,¹¹ in 1920, analyzed the possible causes of massive collapse and concluded that it was produced "by the onset of inflammation affecting the muscles of the crus of the diaphragm, situated behind the peritoneum, one-half of the diaphragm and its synergistic and antagonistic muscles are out of action owing to inflammation of the muscle or the pleural membrane covering it."

In 1921, Scrimger¹² reported seven post-operative cases among 540 abdominal and rectal operations, six followed herniotomy or appendectomy, one followed hemorrhoidectomy.

In 1922, Elwyn and Girsdansky¹³ reported an instance of massive collapse after a laparotomy for penetrating stab wound of the abdomen. In the same year, Hirschboeck¹⁴ reported three cases following abdominal operations which showed no variation from those already described in the literature. Cutler and Hunt¹⁵ in this year also made a very painstaking study of post-operative pulmonary complications. They mention massive collapse as a possibility but assert that it never has been observed in their experience.

Regan,¹⁶ in 1924, reported a case of collapse of the lung following poliomyelitis. In the same year, Ritvo¹⁷ reported an additional case and presented a very complete study of the subject, with special emphasis on the radiological manifestations of the disease.

Early in 1925 Scott¹⁸ published a complete study of all reported cases. Aside from war wounds (Barling and Morrison^{19, 20}), he found sixty-four cases in the literature, only thirty-six of which were given in sufficient detail for analysis. To these he added four cases of his own observation, all occurring as post-operative manifestations, showing little variation from those previously described. Toward the end of the same year, Chevalier G. Jackson and Walter E. Lee²¹ showed the relationship between lobar atelectasis and obstruction of the bronchi by foreign bodies or secretion.

In 1926 and 1927, the writer²² reported five cases each presenting some unusual feature. These will be discussed in greater detail later on in this communication. During 1926, additional cases were reported and the subject discussed from various angles by Mason,²³ Junghagen,²⁴ Trout and Hovter,²⁵ Eades,²⁶ and Beals.²⁷ None of these reports, however, served to throw any light on the etiology.

In 1927, Beigamini and Shepard²⁸ reported two cases of bilateral atelectasis which resulted in death. Both came on immediately following operation. One was in a woman who was operated for fibroid. She was in good condition before operation but died on

the table, autopsy revealing bilateral atelectasis. The second case followed septic abortion. Santee⁴ reported a similar case.

Scott and Joelson² call attention to the influence of posture on the development of massive collapse and cite a very remarkable case in which on two separate occasions the same individual was operated for kidney stones on either side and suffered massive atelectatic collapse of the *opposite lung on each occasion*. They cite numerous other instances where the position of the patient may have been a definite factor in producing the collapse. Churchill and Holmes^{28, 29} stress the theory that "collapse is the result of a combination of obstruction of the bronchioles by inflammatory oedema and secretion and reflex immobility of the diaphragm". Churchill asserts that bronchial obstruction is essential to collapse. Hearn and Clerf³⁰ demonstrate progressive reinflation after repeated bronchoscopic examination and removal of mucus. Additional reports and discussions in 1927 were made by Benedetti,³¹ D. Y. and J. P. Keith and Bell,³² Solem,³³ Mastics, Spittler and McNamee,³⁴ Asper,³⁵ Campbell,³⁶ Diez,³⁷ Garrett,³⁸ McKinney and Porter,³⁹ Kletz,⁴⁰ Brennemann,⁴¹ Leopold,⁴² F. J. Smith and Davidson,⁴³ Peppard,⁴⁴ Scholty,⁴⁷ Tidy and Phillips,⁴⁸ Carlson and Luckhardt,⁴⁹ Harrington,⁵⁰ and Lewd and Rityo.⁵¹

TWO GENERAL TYPES OF INVOLVEMENT

From a consideration of the reported cases it will be found that the disease manifests itself in two more or less well-defined forms: one in which the symptoms of respiratory distress predominate, the other in which any respiratory phenomena are entirely overshadowed by other manifestations. In the first type, the onset is usually quite sudden, within one to four days after operation or trauma, with pain in the chest, dyspnoea and rapid pulse. The patient may even become cyanotic. The temperature, usually normal at first, later acquires an irregular character, ranging from 98.6° to as high as 102.5° or 103° F, within a few hours. After a few days a cough develops and there may be a small amount of mucopurulent sputum. The development of the fever seems to run parallel to the quantity and character of expectoration. The sputum is never bloody or of the "prune juice" type. The white blood count is somewhat higher than normal, advancing steadily, and with the appearance of mucopurulent sputum reaches as high as 20,000 per cmm.

In the second type the pulmonary symptoms, as has been said, are entirely secondary to other symptoms—either an exciting trauma or operation, or some pain in a distant part. There is no pain in the chest and little if any embarrassment of the respiration or change in the pulse rate. Although the cough, fever and leucocytosis may subsequently develop, they are usually attributed to the inciting condition. In such cases the chest condition is usually discovered incidentally during physical or radiographic examination.

Regardless of the type of involvement, the duration is usually from one to three weeks. The condition may terminate rapidly by a sudden reinflation, and reestablishment of the respiratory function or may require several weeks for complete recovery. When sudden reinflation occurs, the reexpansion of the lung can be detected immediately in the radiograph, the lung field taking on a normal appearance in a few minutes. The slower method shows an irregular reestablishment of the respiratory function by successive aeration of small patches of lung tissue, complete reinflation requiring several days or weeks.

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Pathology—Very few autopsies are recorded from which the true character of the pathology involved in the condition can be determined

Pasteur⁶ recorded eight autopsies in which massive collapse of the lung followed diphtheritic paralysis of the diaphragm, in five of which massive atelectasis was demonstrated. He was unable to find any bronchial obstruction which could account for the condition in any instance. In every case he noted a thick fibrinous exudate over the diaphragmatic surface and pleura. Bradford,¹ Briscoe,¹¹ Bergamini and Shepard,³ Santee⁴ and others have made similar autopsy observations in cases which followed war wounds and operations.

Bradford failed to reveal any evidence of "gross lesion such as bronchial obstruction, pleural effusion, etc., interfering with the free entry of air." Elliott and Dingley⁸ emphasize the presence of a large amount of mucopurulent secretion in the bronchioles.

Bergamini and Shepard failed to find any evidence of obstruction. "Gross examination of the collapsed lung gave no evidence of bronchial obstruction. There were no gross particles in the bronchi. Neither was there any of the mucopurulent secretion so strongly emphasized by Elliott and Dingley and by Churchill as a probable etiological factor. Uniform dilatation and engorgement of the capillaries, arterioles and venules strongly suggest probable vasomotor disturbance."

Santee records similar findings.

Briscoe found a thick fibrinous exudate over the pleura and diaphragm similar to the findings recorded by Pasteur.

Microscopic section of specimens in all instances showed extensive atelectasis, but in each instance a few rounded globules of air remained.

Case I of our series was autopsied disclosing the same general condition. A similar exudate covered the pleura, and microscopic examination of the lung tissue showed atelectasis without cellular reaction. On opening the pleural cavity the chest wall resumed its normal contour and the lung did not fill the chest cavity.

CASES OBSERVED BY THE WRITER

Six cases have come under my own observation. These I describe, not only on account of the rarity of the condition, but also because each case has certain features which are somewhat unusual. Of these the first five have been previously reported in the *Jour Amer Med Assn*, vol LXXXVIII, p 1539²²

CASE VI is here presented for the first time and is unique in that it represents a complete radiographic record of this condition from the time of injury, throughout the developing collapse, to complete subsequent inflation. This case occurred on the service of Doctor Cole, to whom I am indebted for this report. A G, white, male, aged twenty, was admitted to the hospital at 4 45 A M, on January 18, 1928, shortly after the automobile which he was driving had been struck by a railroad train. Physical examination disclosed multiple abrasions, contusions and lacerations of the scalp, body and extremities. X-ray examination revealed the twelfth rib on the right side completely pulled from its spinal attachment and displaced about an inch to the side (Fig 1). There was no evidence of other injury to the skull, spine or chest, no evidence of a hollow viscus (no free air in the abdomen) and *the diaphragms were in normal position*. Shortly after admission, the patient passed blood in the urine. On admission, temperature was 98.4° F, pulse rate 112, respirations 24 per minute, blood pressure 115/55, white blood cells, 7,000.

On the afternoon of the same day (January 18), radiographic examination of the chest was made (Fig 2). In the few hours intervening between these examinations, the right diaphragm had become elevated, and was immobile, there was also an irregular accentuation of the lung markings throughout the right chest. Physical examination made the morning of January 19 (scarcely more than twenty-four hours after the injury),

revealed a flat percussion note over the entire right chest. Radiographic examination on January 20, showed a typical picture of massive collapse of the lung (Fig 3). During the night, the pulse rate reached 140 per minute and the respirations were as frequent as 40 per minute. Within a few hours these dropped to a pulse rate of 88 and respiration rate of 20. Further radiographic examination, made January 23, revealed almost complete reexpansion with only a very small atelectatic area remaining in the lung (Fig 4). No therapeutic measures were attempted, other than the ordinary rolling about in bed.

The points of interest in this case were

(1) The complete record afforded by examination within a few hours after injury, showing the diaphragmatic position normal, (2) the radiographic record in the films taken within ten hours after injury, showing the beginning of collapse, (3) the evidence of complete collapse within twenty-four hours after injury, and (4) the spontaneous reexpansion.



FIG 1.—Case VI. Patient was struck by a train a few hours before which resulted in complete severance of the twelfth rib from its spinal attachment. The urine contained blood showing injury to the kidney on this side. Film taken at that time showed normal position of the diaphragms.

ETIOLOGICAL THEORIES

From a consideration of all reported cases four hypotheses have been advanced as possible explanations of the cause of this condition.

1. The paralytic theory, that the collapse of the lung is due to pressure exerted by the collapsed chest wall and elevated diaphragm, resulting in turn from paralysis of these structures. That the resulting sluggishness of respiration permitted collection of secretion in

bronchioles which caused this obstruction, and that the air remaining in the alveoli of the obstructed area was absorbed by the circulating blood. In other words, the pressure of the chest wall and diaphragm is considered primary, the lung collapse, secondary. (Supported especially by Pasteur.)

2. The diaphragmatic infection theory, "that due to the onset of inflammation affecting the muscles of the crus situated behind the peritoneum, one-half of the diaphragm and its synergistic and antagonistic muscles are out of action owing to inflammation of the muscle or the pleural membrane covering it." This results in a disturbance of the respiratory function which in turn leads to collapse. (The view held by Briscoe.)

3. The spasmodic reflex theory, that some spasmodic reflex of the bron-

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chioles causes them to become occluded, permitting the subsequent absorption of air in the segment of the lung involved (Explanation advanced by Sir John R. Bradford)

4 The simple obstruction theory, that obstruction of the bronchioles by secretions is the entire explanation, such a condition being all that is necessary for the development of the other features of the condition, and any disturbance of the respiratory function, purely incidental (Observations of Jackson and Lee)

5 The angioneurotic theory that the rapidity of development of the condition in certain instances and the dilatation of the capillaries and engorgement of the blood-vessels lend credence to this theory according to Bergamini and Shepard Both Gwyn⁴⁵ and Scott also mention this possibility

6 The posture theory that the position assumed by the patient during post-operative convalescence may favor the production of this condition This view is held by Scott and Joelson

7 The theory of combined obstruction and impaired respiration that "collapse is the result of a combination of obstruction of the bronchioles by inflammatory edema and secretion, and reflex immobility of the diaphragm," the view held by Churchill, and also mentioned in substance by Elliott and Dingley

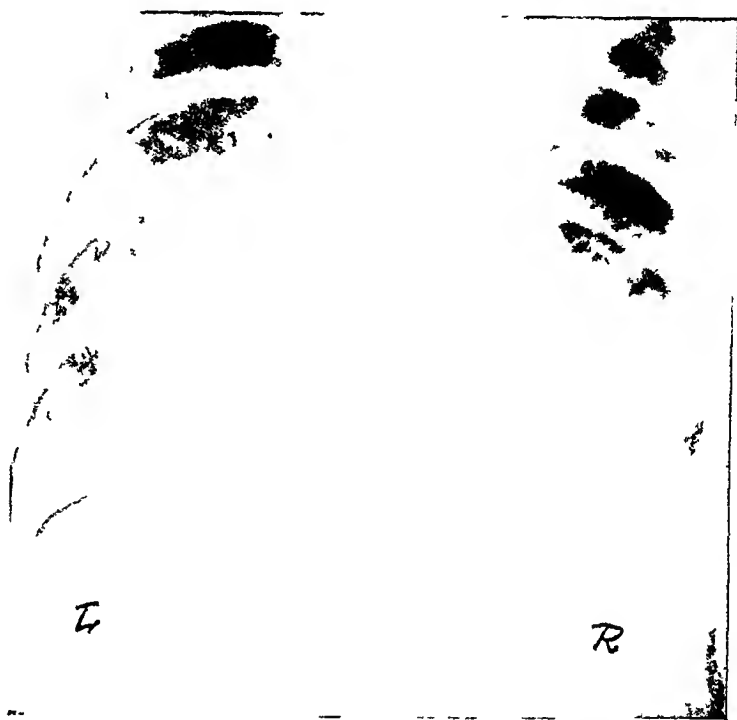


FIG. 2—Case VI Twelve hours later, elevation and immobilization of the diaphragm was noted, and a definite haziness and accentuation of the lung markings over the right lung The process was evidently going on at this time

DISCUSSION BASED ON CLINICAL OBSERVATIONS, PATHOLOGICAL FINDINGS AND EXPERIMENTAL EVIDENCE

The original contention of Pasteur that this atelectatic condition was due to the pressure of the depressed chest wall which resulted from paralysis of the diaphragm and other respiratory muscles, is not borne out by the facts In patients suffering from tuberculosis, in whom one of the phrenic nerves has been sectioned as a therapeutic measure, this condition has never resulted, consequently some other factor must have been a contributing cause in Pasteur's original cases Elliott and Dingley performed experiments on rabbits, sectioning the phrenic nerve and other nerves influencing respiration and never witnessed this phenomenon Biscoe likewise performed section of the phrenic

nerve with similar results, while Coryllos and Birnbaum⁴⁶ failed to produce the condition after phrenicotomy

At the autopsy of our first patient, on opening the chest cavity, the chest wall assumed its normal contour and the lungs failed to fill the entire cavity. This would indicate that the depression of the chest wall was secondary to lung collapse and not the primary factor in producing this lung condition. In Case V of our series also, where atelectasis was associated with pneumothorax, the chest wall was never retracted. Elkin⁴⁷ measured the intrathoracic pressure in patients suffering with massive collapse and found the negative intrapleural pressure increased. Normally the intrapleural pressure varies from

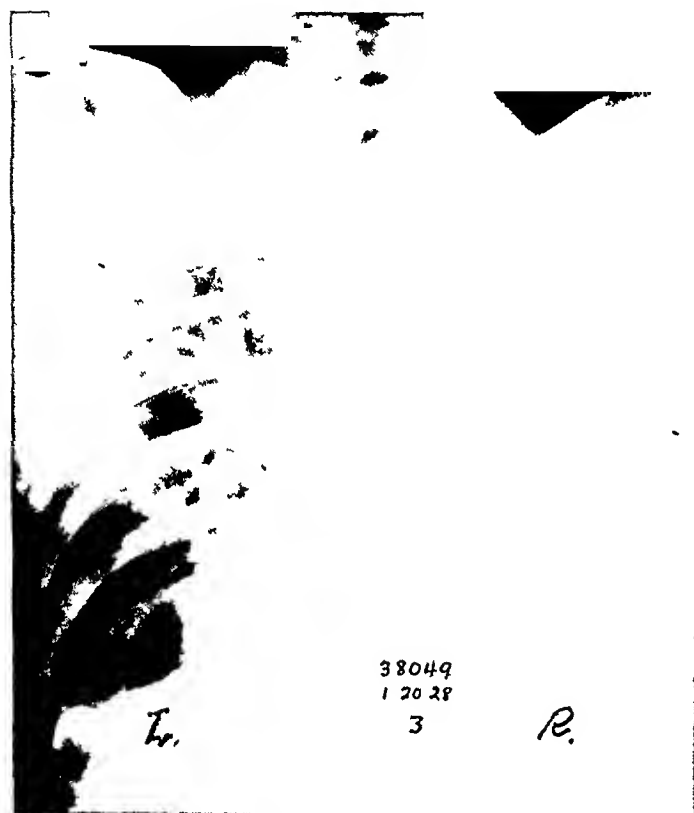


FIG 3—Case VI. Twenty four hours after injury there was complete atelectatic collapse of the right lung

—9 mm Hg on inspiration to —2 mm Hg on expiration⁴⁸. In the three cases cited by Elkin, the negative pressure was more pronounced in both chest cavities. The greatest variation noted was —12 mm Hg on inspiration and —15 mm Hg on expiration on the involved side, —6 mm Hg on inspiration and —8 mm Hg on expiration on the uninvolved side. In the roentgenographic observations made in Cases I and VI, there was retraction of the trachea before definite indications of collapse of the lung or sinking in of the chest wall. In Case V, where spontaneous pneumotho-

rax occurred in association with massive atelectatic collapse, the chest wall did not become sunken and there was little if any displacement of the walls of the pleural cavity. We must conclude, therefore, that massive collapse of the lungs does not occur solely as a result of paralysis of the diaphragm or other respiratory muscles, nor from pressure of the chest wall.

Briscoe's supposition that collapse is produced by a lack of synchronism between the diaphragmatic movements brought about by retroperitoneal infection of the crus of one or other diaphragm, cannot be upheld because at best it would explain abdominal cases only, and post-operative cases in which there had been infection. Many cases have been cited where the condition came on so quickly after trauma (gunshot wound) that infection would be impossible.

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The cases reported by Bergamini and Shepard and by Santee in which collapse occurred during operation, would rule out infection as an indispensable cause. In Cases II and VI of our series, also, collapse followed so soon after injury as to make infection impossible. Biscoe's basis for this assumption of infection as a cause lies in the detection at autopsy of a thick fibrinous exudate over the pleura and diaphragm. A similar exudate was noted by Pasteur in his autopsies of post-diphtheritic patients and in the autopsy which was performed in Case I of our series this finding was also confirmed. In all of these cases, however, a previous infection had been established. No evidence of such an exudate was present in any of our cases in which sudden complete reinflation occurred. Complete, rapid reinflation was noted in Cases II, III, IV and VI and in none of these was there evidence of such an exudate. Reinflation was so rapid that there would

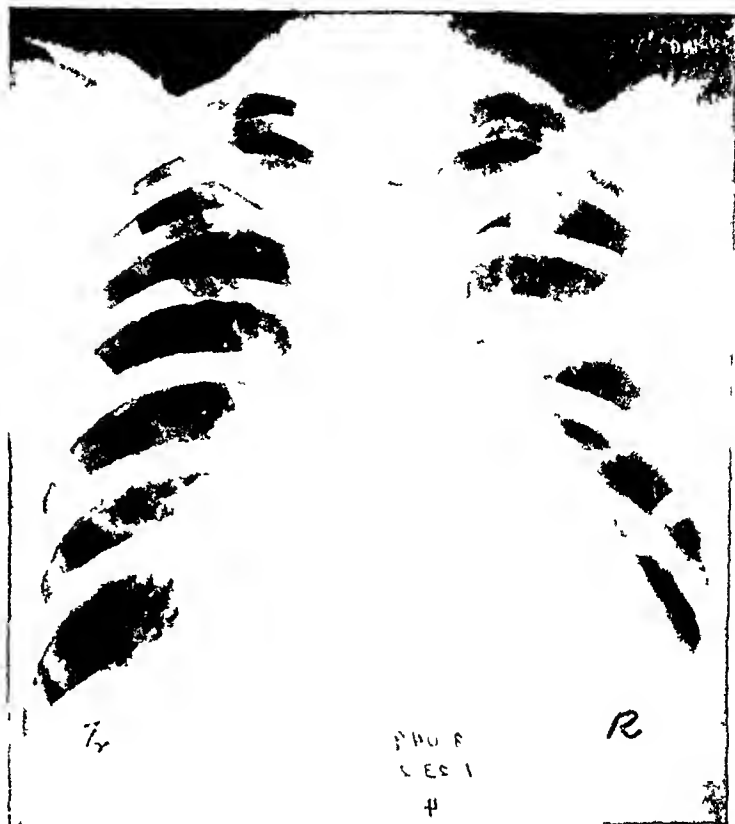


FIG. 4—Case VI Showing appearance after reestablishment of function. Spontaneous reinflation occurred in this case.

have been no time for the absorption of an exudate had it been present. The autopsy reports of Bergamini and Shepard and of Santee on their cases do not mention this finding.

We must conclude, therefore, that surely, in many cases, infection of the diaphragm plays no part in the production of collapse and that in such cases where a thick, pleural exudate does form over the diaphragm and pleura, it is rather the result of inactivity of the diaphragm than the cause of any interference with its motion. In every case reported in the literature, the appearance of an exudate is in association with an established infection.

The theory advanced by Bradford, that collapse of the lung is brought about by a reflex stimulation of the constrictor nerve fibres to the muscles of the bronchioles, remains still to be considered. Ample experimental evidence is found of the existence of constrictor nerves and muscle fibres on the bronchioles sufficiently strong to produce complete and prolonged constriction (Longet⁴⁹, Auer and Lewis⁵⁰). That such constriction ever results in atelectasis, however, has never been proven. The frequency with which the condition follows abdominal operation would lead one to suspect that an insult to

the vagus nerve might offer the reflex stimulus for this occurrence. Briscoe, however, performed numerous experiments in which in an attempt to produce this reflex spasm he irritated the peritoneum, stimulated the vagus, etc., all without results. There is, therefore, no direct evidence in support of the view that reflex *bronchial spasm* is the cause of the disease, although there is evidence to indicate that *contractions of the bronchial musculature* may be sufficiently powerful to shut off the bronchus.

Bronchial obstruction by secretion alone is the cause suggested by Jackson and Lee. Long before the discovery of this condition it had been observed that when a foreign body completely occluded a bronchus, the portion of the lung supplied by the obstructed bronchus became atelectatic. Mendelssohn⁵¹ in 1845, and in the following year, Traube,⁵² produced atelectasis by occluding the bronchus with paper wads, shot and acacia. Lichtheim⁵³ in 1879, found that introduction of a stick of laminaria into a bronchus of a rabbit caused atelectasis of its lung segment within a few hours, provided the circulation of the blood was left intact. If the blood-vessels to this section of the lung were ligated simultaneously with the obstruction of the bronchus, the air remained in the obstructed lung and atelectasis did not ensue. From this it was concluded that the residual air is rapidly absorbed by the circulation. Similar observations by Chevalier Jackson and his co-workers on foreign-body atelectasis in human beings, has resulted in the same conclusions. Clinicians (Golden⁵⁴, Chizzola⁵⁵) have observed that bronchial tumors, when they completely obstruct, produce within a very short time a complete atelectasis of the segment of the lung supplied by the bronchus.

Partial obstruction results in emphysema. Since the diameter of a bronchus is smallest during expiration, obstruction first occurs during this phase of respiration, the air which is drawn in during inspiration cannot subsequently be expired and remains trapped. This phenomenon is the basis of Manges's⁵⁶ diagnostic sign for non-opaque foreign bodies in the lung. Obstructive emphysema is caused by the partial obstruction of a bronchus. The excellent experimental work of Coryllos and Birnbaum in which a bronchus was obstructed to varying degrees by inflation of balloons introduced through a bronchoscope, serves to confirm these previous observations and to establish beyond a doubt the relationship between complete bronchial obstruction and atelectasis, but leads no closer to a solution of the problem in spontaneous "massive collapse" of the lung, where no evidence of foreign-body obstruction has been found.

Aspiration of secretions alone could hardly explain the condition since patients, aspirating barium sulphate through broncho-oesophageal fistulæ, never develop atelectasis. Likewise, no case is reported after tonsillectomy and there is abundant proof of the extreme degree of aspiration which frequently occurs during this operation. In no recorded autopsy was there any evidence of bronchial obstruction.

That it is possible for thick fluids to result in atelectasis under certain conditions is demonstrated in a case cited by Hickey, in discussing a recent

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communication by Dr. Preston B. Forestier. In Hickey's patient, massive collapse followed the intratracheal injection of iodized oil used for diagnostic purposes.

The rapidity with which the condition develops in certain instances, and the engorgement and dilatation of the capillaries suggests the possibility of vasomotor disturbance as a contributing etiological factor. Gwyn mentions that massive collapse may be due to some such action and Scott also is impressed with this possibility. Bergamini and Shepard state that the "uniform dilatation and engorgement of the capillaries, arterioles and venules strongly suggest a probable vasomotor disturbance." The rapid onset in the cases observed by them "would seem in itself to rule out the theory of obstruction of the bronchi with subsequent absorption of the alveolar air." They suggest some such explanation as angioneurotic oedema.

Posture alone as an etiological factor has been stressed by Scott and Joelsson. To cite one notable case in which massive collapse occurred in the contralateral lung on two successive occasions after operation on the two kidneys, Briscoe had previously suggested position as a possible cause.

The theory of combined obstruction and impaired respiration is the view upheld by Churchill^{28, 29}. He asserts that there can be no atelectasis without bronchial obstruction.

When we consider the facts, we have no clinical or experimental evidence for thinking that atelectasis can occur under any other condition than actual mechanical bronchial occlusion. If we assume that there can be no atelectasis without previous bronchial obstruction then the manner in which the obstruction is brought about alone remains to be considered. What extraneous influences are there which could account for the accumulation of secretion in the larger bronchi? Obviously, the loss of sensation of the trachea and larger bronchi and the consequent interference with the expulsive mechanism which is normally present—cough reflex and ciliary action of the mucous membrane. The cause of such loss of sensation on the part of the trachea and bronchi, then, becomes the chief point of consideration, atelectasis is merely the natural course of events which would be expected under these circumstances. Will loss of bronchial sensation explain all instances and circumstances under which the condition is found?

Infectious cases might well be explained in this manner. There is abundant evidence that extreme toxicity can abolish the tracheal reflex. This is seen in instances where individuals toxic from intestinal obstruction or septicaemia, aspirate barium sulphate into the lungs without discomfort. Pasteur's original cases following diphtheria, cases reported following acute poliomyelitis and Case I of our own series in which the causative factor was probably septicaemia, are examples. The loss of tracheal reflex in operative cases might also be explained either by anaesthesia produced by morphine, or other hypnotics given to quiet the patient, especially if he were permitted to remain in one position for an extended period of time after the operation. Pre-operative

administration of morphine has been offered as a possible explanation of post-operative abscess of the lung, the analgesia produced preventing the normal expulsion of infected material aspirated during operation. This theory would explain contra-lateral involvement which is occasionally encountered in post-operative atelectasis as seen in Case III of our series. The case referred to by Doctor Hickey in which massive collapse followed intratracheal injection of iodized oil, might well have been due to the previous injection of cocaine, administration of morphine, or large doses of luminal (which is supposed to counteract the constitutional effect of cocaine) prior to injection and permitting the patient to lie quietly after injection. But toxicity *alone* will not explain all cases in which the phenomenon occurs.

There remain for consideration those cases in which the condition develops after injury (Cases IV and VI of our series), and severe physical strain. It is conceivable that some reflex might result from injury to a remote part of the body. It is not uncommon to see patients so severely injured in one part of the body that the pain from a less severe injury elsewhere is inhibited or overshadowed. During the war it is possible that severe fighting conditions, high nervous tension and extreme exhaustion incidental to battle, might result in the inhibition of the cough reflex. Numerous instances have been encountered during the war and in civil life where abdominal operations were performed without an anæsthetic upon individuals in a profound state of exhaustion. In the strain of competitive athletics could not the great nervous tension and muscular effort (Case II) produce such reflex inhibition from fatigue?

The one constant finding in all instances is immobilization (not paralysis) of the diaphragm. While the collapse itself is often on the opposite side to the operation or injury which precedes the condition, the diaphragmatic immobilization is always on the same side as the collapsed lung. If aspiration of secretions alone were the cause, diaphragmatic excursion should be resumed after the dislodgement of the obstruction and reinflation of the lung. This is not found to be the case, diaphragmatic immobilization often remains for days or weeks after reinflation. This would seem to indicate that it is inactivated in a defense reflex.

Is it not conceivable that the bronchioles might also be contracted from a similar reflex spasm? Sibilant râles have been detected by others intermittently over the lung during the time preceding collapse, and the same observation has been made by clinicians in our cases before it was known that collapse was developing. May it not be possible, then, that collapse occurs as a result of a combination of all of the factors here noted?

It seems most logical to suppose from the available evidence that massive atelectatic collapse of the lung results from a simultaneous inhibition of the cough reflex by some toxic or reflex stimulus in association with an impairment of the respiratory function, either immobilization of the respiratory muscle from a defense reaction, or paralysis from toxic neuritis. This in turn permits the accumulation of secretions, blocking the bronchi and resulting in

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atelectasis Posture favors the development in the most dependent portion. Occurring alone, these factors may not be sufficient to produce the condition, their simultaneous occurrence, however, may be all that is necessary to result in collapse.

DIFFERENTIAL RONTGENOLOGICAL DIAGNOSIS

Massive (atelectatic) collapse of the lung must be differentiated from (1) Lobal pneumonia (2) Lung abscess (3) Caseous tuberculous pneumonia (4) Broncho-pneumonia (5) Lung tumor (6) Pleural effusion (7) Chronic interstitial pneumonia.

If one bears in mind the clinical history and the typical Rontgen picture of massive (atelectatic) collapse, none of these conditions should cause confusion.

Massive (atelectatic) collapse most frequently follows abdominal operations or other injury to the chest, abdomen, or pelvis. The onset is sudden with pain in the chest, fever, dyspnoea, rapid pulse and leucocytosis. There are the physical signs of massive consolidation. At this stage the condition may resemble lobal pneumonia, especially insofar as pneumonia is a frequent post-operative complication. The one distinctive sign is the retraction of the heart and mediastinal structures toward the involved side and sinking in of the chest wall on that side. Uncomplicated lobal pneumonia does not produce deviation of the trachea or displacement of the mediastinal structures. If alveolar absorption takes place rapidly and there is still some obstruction of the bronchi by secretions, displacement of the trachea may be present as a manifestation of the atelectasis present. Under these circumstances lobal pneumonia in the resolving stage cannot be differentiated from massive collapse. If only a single lobe, for instance the upper, is collapsed, the phenomenon of sinking in of the chest and pulling over of the heart does not occur, since the slight difference in space caused by collapse of a single lobe is compensated for by emphysema of the remaining aerated lung. Even in this instance, however, there will be definite displacement of the trachea which will establish the true nature of the condition. If there is ever doubt about the consolidation being due to lobal pneumonia, lung abscess, caseous tuberculous pneumonia, or any consolidation other than massive collapse, a safe diagnostic procedure is to roll the patient over upon his uninvolved side and cause him to cough. An atelectatic lung where there is no bronchial obstruction should immediately reinflate, consolidation from other cause will not be affected.

After a few days the patient begins to cough, and after a time brings up a varying amount of mucopurulent sputum. At this stage the condition may be mistaken, clinically, for lung abscess or caseous tuberculous pneumonia. Rontgenographically, however, the picture is usually quite distinctive. The formation of secretion, it should be remembered, is one of Nature's methods by which inflation is reestablished, so that at this stage, patches of reinflation may be seen here and there in the atelectatic area, and the picture may become confused. With beginning reinflation of the lung, the first structure to return to normal position is the trachea, so that this might have resumed its position in midline if there is much evidence of reinflation. The narrowing of the

interspaces and shallowness of the chest on the affected side would still be present to establish the diagnosis, however. At a somewhat later stage, where the process has been allowed to go on to reinflation by degrees, a stage is reached in which all of the displaced structures again assume their normal positions, and even at this stage there may be considerable irregular atelectatic areas remaining in the lung. It may, just at this time, be impossible to differentiate the condition from broncho-pneumonia. Massive collapse, however, is unilateral, and broncho-pneumonia is usually bilateral.

Tumors of the lung may reach such enormous proportions as to completely fill the chest. Such tumors may continue to grow until they cause a displacement of the heart and mediastinal structures to the opposite side, but they never cause retraction toward the involved side, unless by their growth they occlude a bronchus which results in subsequent atelectasis.

Large pleural effusions, likewise, may produce a homogeneous shadow involving one entire side of the chest. In this condition, displacement of the heart and mediastinal structures away from the involved side is the rule. Such displacement may not be present due to fixation of the mediastinum from previous infection, but retraction of the mediastinal structures toward the involved side never results. Occasionally a long-standing pleural effusion may have developed sufficient scar tissue in its surrounding capsule to cause retraction of the trachea, but this is very rare, and the other elements of the case will usually establish the true nature of the process.

Chronic interstitial pneumonia (chronic diffuse fibrosis of the lung) is the only other massive consolidation which causes retraction of the heart and mediastinal structures *toward* the involved side. This condition is chronic, however, usually following some suppurative process in the chest and the scar tissue which causes the pulling over of the mediastinum likewise exerts its traction on the walls of the bronchi, causing bronchiectatic cavities to form. These can be clearly seen through the consolidation. They never occur in association with massive atelectatic collapse.

TREATMENT

The fluoroscopic observation of immediate reinflation of the collapsed lung after rolling the patient back and forth on the uninvolved side (affected side uppermost) and causing him to cough, gives a logical basis for this procedure as a therapeutic measure. This simple expedient has resulted in immediate reinflation in every instance which we have observed, and numerous confirmations of the observation have been brought to the writer's attention in this country and abroad. Chevalier Jackson and his co-workers, Hearn and Clerf, have shown that reinflation occurs following bronchoscopic removal of mucus from the bronchi. The process of reinflation may be slow, however, and often is complete only after several bronchoscopic examinations. It would seem advisable, then, in all instances to attempt the simple expedient of rolling the patient on the uninvolved side and causing him to cough before bronchoscopic procedure is instituted. Should this measure fail to produce reexpansion

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sion bronchoscopic examination should be resorted to, in order to detect any mechanical cause for the collapse. Doctor Jackson and members of his clinic have demonstrated numerous instances of atelectasis from bronchial occlusion by new growths, foreign bodies and anomalies of the bronchi, these conditions represent atelectasis from mechanical obstruction and are in no way similar to the cases here under discussion. Obviously simple change in position would have no effect on the atelectasis produced under such circumstances and bronchoscopic examination would be indicated for the detection of its cause.

SUMMARY

1 Massive atelectatic collapse of the lung is a definite clinical entity. This name should be reserved for cases following out the general clinical course herein mentioned in which there is collapse of a previously well-aerated lung without mechanical obstruction from foreign body, tumor or anomaly. This name is not entirely descriptive of the condition and will probably give place in time to a more scientific designation. The term "acute lobar idiopathic atelectasis" has been suggested by Dr. Seth I. Hirsch*. Congenital atelectasis and atelectasis from mechanical cause such as foreign bodies, tumors and anomalies should not be so considered.

2 It is characterized by sudden collapse of one or more lobes in a lung previously well aerated from some unknown cause.

3 It is most frequently observed after abdominal operations, wounds and other injuries such as fractures of the pelvis or femur, but may follow apparently trivial injuries.

4 Rontgenographically, there is a dense consolidation corresponding to one or more lobes or to an entire lung, homogeneous in character and resembling consolidation from pneumonia. The narrowing of the chest on the involved side, the approximation of the intercostal spaces, the elevation of the diaphragm and the drawing over of the heart and mediastinal structures toward the involved side, make the condition readily recognizable.

5 It seems most logical to suppose that the condition is due to a simultaneous inhibition of the cough reflex by some toxic or reflex stimulus in association with an impairment of the respiratory muscles, either immobilization from a defense reaction or paralysis from toxic neuritis, which permits secretions to accumulate and block the bronchus, and atelectasis results. Neither alone is able to bring about this condition, a simultaneous occurrence is necessary for its development.

6 The treatment is simple and consists in rolling the patient back and forth on the uninvolved side. Ordinarily no other therapeutic agent is necessary. This simple procedure has, in all instances in which we have instituted it (five), proved successful in promptly reestablishing aeration of the lung. Jackson and his co-workers have reported reinflation after repeated

* Personal communication.

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bronchoscopic removal of mucus from the bronchi and bronchoscopy should be resorted to if this simple manœuvre fails

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SURGICAL LESIONS OF THE BILIARY TRACT*

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THE clinical and statistical features of this report are based on a study of two hundred consecutive cases of diseases of the biliary tract, admitted to the service of the writer during the past four years in the wards and private rooms of The Brooklyn Hospital

The majority of these patients (about 65 per cent) had been previously observed and a provisional diagnosis made in our out-patient department, but after admission to the hospital, all of them were personally studied and cared for by the writer, or one of his associates, with the definite aim of attempting to clarify our own opinions and the viewpoint of our staff as well as to correlate, if possible certain clinical and operative findings with the laboratory studies and end results After hospitalization most of these patients were again returned to the clinic for follow-up observation and appropriate after-care where they were seen at regular intervals by the same members of the hospital staff, thus ensuring a unified system of surgical care and sequential study in the hands of a rather small group of men

The results of laboratory investigations included, are based not only on a study of the two hundred cases covered in this analysis, but also on the examination of material secured from the patients of other surgeons in the same hospital This review of pathological material was undertaken by James Denton at the same time that our clinical observations were begun In all, over four hundred gall-bladders were studied and the results of Denton's observations were summarized and published in the *Archives of Surgery*, in January, 1927 In brief, he was able to characterize lesions of the biliary tract as primarily mechanical and circulatory disturbances rather than infectious ones This conception, while at complete variance with the generally accepted explanation of gall-bladder disease, has been found of value to us in establishing a better understanding of the conditions encountered and we, therefore, propose to present an analysis of our material in the light of this altered point of view

In the first place, it may be of advantage to delineate briefly our conception of the salient features of biliary tract disease, based primarily on clinical observations but attempting at the same time to keep in mind the results of pathological and bacterial studies which we believe to be accurate and useful

In our experience, by far the greater number of disturbances of the biliary tract which may be successfully managed by the surgeon, and with the greatest relief and satisfaction to the patient, are those which have their basis in obstruction to the normal flow of bile through the duct system and by far the most common and frequent cause of such obstruction is the presence of stones,

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gravel, or inspissated bile in the gall-bladder, cystic, common or hepatic ducts. The symptoms and effects of stones depend on their size, number, to some degree on their chemical characteristics, and finally on their location in the duct system. They may be found in any of the following places:

1 In the intrahepatic ducts 2 In the extrahepatic ducts 3 In the gastro-intestinal canal 4 In the peritoneal cavity 5 In the gall-bladder

Stones in the Intrahepatic Ducts—When stones are located in the intrahepatic ducts the damage done to the liver depends on whether the stones are large or small, single or multiple, and upon what proportion of the duct system is involved or obstructed. If, as is usual in this location, the stones are small or in the nature of what is commonly called gravel, only partial obstruction of the duct radicles ensues, the effects are not serious and usually confined to a small portion of the liver. When of greater size and located in the larger intrahepatic radicles the entire liver will be intensely engorged with bile and there may result extensive necrosis of liver cells from back pressure. This condition is probably what is generally termed or understood as hepatitis in association with biliary tract disease. Intrahepatic stones may be complicated by an ascending cholangitis but in this location they do not often lead to complete occlusion of the duct system, and the condition is seen more often at autopsy than clinically.

Stones in the Extrahepatic Ducts—Stones in the extrahepatic ducts constitute the most serious result of gall-stone formation. In this location, the gravity of the situation depends, in a large measure, upon the completeness of the occlusion. Cases are not infrequently seen at autopsy in which a stone of considerable size had been present in the common duct for a long period of time with enormous dilatation of the duct and still with no serious effect on the liver substance. Sudden and complete obstruction of the duct by stone, however, always results in obstructive jaundice and invariably calls for prompt surgical intervention. In contradistinction to the gall-bladder, impaction of stone in the common duct is not infrequently complicated by ascending infection of the duct system and ascending cholangitis results. This, of course, adds to the seriousness of a condition already in itself a menace to life. Cholangitis is, as a rule, obviously infective or bacterial in origin.

If a stone is impacted in the ampulla of Vater and if the ampulla receives both the bile and pancreatic ducts, either the retrojection of bile into the pancreas or escape of pancreatic enzymes may result in hemorrhagic necrosis of the pancreas. That hemorrhagic pancreatitis is frequently a complication or result of obstruction or inflammatory disturbances in the biliary system, there can be little doubt.

Stones in the Gastro-intestinal Canal—Four cases of partial or complete intestinal obstruction due to the presence of large gall-stones in the intestinal canal, have been observed in The Brooklyn Hospital during the past few years. The location of the fistulæ through which they have entered the intestine has been variable, but in each instance it was assumed that stones of such enormous size (in one instance as large as a hen's egg) must have ulcerated

through the gall-bladder wall into an adherent loop of intestine, the size of these stones was such as to have precluded their original presence or existence in any location other than the gall-bladder

Gall-stones in the Peritoneal Cavity—We have operated on three patients in whom gall-stones were found free within the cavity of the peritoneum. In two of these the rupture of the organ was apparently spontaneous, there was little or no evidence of gall-bladder pathology and the peritonitis ensuing was nothing more than a transitory chemical reaction from the irritation of the biliary secretion on the peritoneum. The third case was that of a ruptured gangrenous gall-bladder in which a simple drainage operation resulted in the uncomplicated recovery of the patient. In this case, numerous stones were lost within the peritoneal cavity, but after a lapse of three years the patient has never manifested any symptoms referable to the presence of these foreign bodies. Other cases have been reported in which gall-stones were found encysted within the folds of the omentum or in other locations within the peritoneal cavity. They may, and in some instances do, lead to localized abscess formation, but rupture of the gall-bladder and the escape of bile and stones into the general peritoneal cavity need not necessarily cause more disturbance than a transitory chemical peritonitis.

Stones in the Gall-bladder—The presence of stones in the gall-bladder may or may not be accompanied by symptoms or appreciable pathological changes in the organ or any other part of the biliary tract. Such stones appear often to be harmless foreign bodies although invariably a potential source of trouble and danger. We have on many occasions, when operating for other conditions, seen gall-bladders both large and small containing many stones in which the patient had never complained of symptoms and in which the organ grossly and histologically showed little or no pathological change. Cultures made from gall-bladders freshly removed and containing stones were frequently returned with negative results, and stained sections of many parts of the mucosa and gall-bladder wall in numerous instances failed to reveal the presence of bacteria, and showed none of the characteristic changes associated with infection.

In cases, on the other hand, in which pathological change is easily recognizable, such changes appear to be the result of mechanical and circulatory disturbances due to the presence of a foreign body and usually to its impaction in the cystic duct.

That a secondary infection may and often does develop as a result of the presence of stones, and the trauma produced thereby cannot be denied and yet, we are entirely at variance with those who maintain that gall-stones do not develop except in the presence of an infected medium and that they are invariably the end-result of bacterial invasion.

It seems to us as the result of our own clinical and laboratory experience, that a disturbance or unbalance of body chemistry in its relation particularly to cholesterol and calcium metabolism must be the important and primary factor in the etiology of cholelithiasis. It would seem also that the recent

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investigations of Wells, Benda, Dewey, Boyd, Sweet and others would tend to support this contention

Gradual occlusion of the cystic duct by a stone appears usually to result in mucous hydrops of the gall-bladder. Sudden occlusion is accompanied by marked edema of the gall-bladder wall and hemorrhage either into the cavity of the organ or between its several layers. This is the condition observed after a severe biliary colic associated with impaction of a stone in the cystic duct and if repeated often enough there ensues marked thickening and fibrosis of the gall-bladder wall itself.

Such effects are produced in the first instance by interference with the venous circulation, and when severe enough to seriously obstruct or block the arterial supply there results a partial or complete infarction or gangrene of the organ depending upon the degree of occlusion or thrombosis of the vessels.

There can be no question but that stones pass down through the duct system and into the intestine. In cases where the gall-bladder shows obvious pathological change but where no stones are found it is not unreasonable to assume that such changes had their origin in circumstances connected with the previous presence and passage of calculi.

We cannot agree with those who have likened the acute gall-bladder to the acutely infected appendix. Their constitutional symptoms, temperature reaction, blood picture, pathogenesis and bacteriology are not in any way analogous.

The acute gall-bladder, even though perforated and with a resultant intra-peritoneal abscess rarely shows any tendency toward the development of a spreading peritonitis and the organisms recovered from such cases are of different strains and types from those associated with suppurative lesions of the appendix. In so-called empyema of the gall-bladder, in which the cavity of the organ is distended with a thick mucoid material of yellowish or greenish-yellow tinge, we have often failed to recover pathogenic organisms and smears were frequently negative for pus cells and bacteria. Even in the most severe cases in which secondary infection had supervened, the formation of plastic exudate and other evidences of a spreading and severely infective peritonitis, such as are often seen in the lower abdomen, were lacking.

In chronic disease of the gall-bladder in which no stones were found the pathologic changes most commonly noted were fibrosis and involution atrophy, the same as may be seen in many other tissues and organs in patients past middle life. It is our belief that such changes may be understood and explained on the basis of circulatory disturbance associated with prolonged or chronic venous stasis of mechanical origin.

In the pathological material examined in such cases in our series the presence of infection could not be demonstrated.

CLINICAL ANALYSIS

When we began these observations, about four years ago, it was decided to institute a logical method of study and procedure and except for a few acute

cases, obviously in need of prompt surgical relief as an emergency measure, the policy of conservatism was adopted for two reasons

First Because we had come to believe that the average acute gall-bladder may, with advantage, be allowed to subside and the surgical procedure undertaken after the cessation of acute symptoms with greater safety to the patient

Second For the reason that in many patients with suspected biliary tract disease we have felt that sufficient time should elapse, not only for the purpose of making complete and accurate diagnostic studies, but also in the interest of determining, in each instance, the factor of safety or operative risk

Since the adoption of this policy we are aware of no instance in which it has been detrimental to the patient, whereas previously, when it was our custom to regard the average acute gall-bladder as similar to suppurative appendicitis, and to institute radical surgical measures with corresponding promptitude, we can recall several instances in which disastrous results might have been avoided by a more careful and delayed consideration of the surgical indications and predetermination of the operative risk

The method of observation and study which we have applied to these patients has been in no way different from those measures employed in many other surgical clinics Without unnecessary waste of time we have attempted to utilize, in logical order, all of those various diagnostic and pre-operative aides which have come to be recognized as of any direct or indirect value and by so doing it has been possible in most instances to make accurate estimations of the underlying pathology, to convert poor operative risks into comparatively safe ones, and to carry out the indicated surgical procedure at a time and in a manner least detrimental to the patient

Without going into the details of history, physical signs, X-ray findings and laboratory data, the analysis of our cases may be best summarized in tabular form

TABLE I

Analysis of 200 Cases of Biliary Tract Disease

Acute cases (with primary or recent colic)	23
Acute exacerbations in chronic cases (based on pathology)	31
Chronic cases (including 8 carcinomas)	146
Total	200
Age limits—15 to 86 years	
Males—50 Females—150 Ratio—1 to 3	

Distribution in Decades

2nd Decade	2 cases
3rd Decade	29 cases
4th Decade	46 cases
5th Decade	57 cases
6th Decade	47 cases
7th Decade	16 cases
8th Decade	2 cases
9th Decade	1 case
Total	200 cases

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TABLE II *Cholelithiasis*

Acute cases	42
Chronic cases	78
	<hr/> 120 or 60%
<i>Associated Pathology</i>	
Pancreatitis—In acute cases	16
Pancreatitis—In chronic cases	22
	<hr/> 38 or 19%

TABLE III *Gastric and Duodenal Ulcer Associated*

Ulcer—Gastric	Acute cases— 2
Ulcer—Gastric	Chronic cases— 4
Ulcer—Duodenal	Acute cases— 2
Ulcer—Duodenal	Chronic cases—21

Malignant Disease

Carcinoma gall-bladder and common duct	4
Carcinoma hepatic duct	1
Carcinoma pancreas	3
	<hr/> 8 or 4%

TABLE IV *Appendectomy and Cholecystectomy*

Acute cases	16
Chronic cases	79
	<hr/> 95

Pathologic appendices (gross pathology) about 10 per cent

TABLE V *X-Ray Studies*

Gastro-intestinal series (including gall-bladder) taken in	108 cases
Of diagnostic value in	94 cases
Stones shown by X-ray in	24 cases
Extra-biliary evidence of gall-bladder disease in	70 cases
<i>Tetraiodide Test (Graham)</i>	
	90 cases

Made in
Agreement with operative findings in last 11 cases
(Value apparently increasing with cumulative experience)

TABLE VI *Surgical Résumé*

Patients operated upon	184
Patients not operated upon	16
	<hr/>
<i>Cases not Operated Upon</i>	
Acute—Allowed to subside	5
Acute—Moribund on admission	1
	<hr/>
	6
Chronic—Refused operation	1
Chronic—Pregnancy	1
Chronic—Risk out of proportion to symptoms	8
	<hr/>
	10
	<hr/>
	16
Total	

TABLE VII

Operations

Cholecystectomy	165
Cholecystostomy	11
Choledochostomy	10
Cholecystgastrostomy (cancer of pancreas)	2
Simple drainage of gall-bladder and localized abscess	2

Associated Operations

Appendectomy	95
Gastro-jejunostomy	3

TABLE VIII

Mortality

Operations—184	Deaths—18	Rate	9 7%
Cancer cases—5 (gall-bladder, hepatic and pancreatic ducts)			2 7%
Deaths in acute cases (6 in 54)		11	plus
Deaths in chronic cases (7 in 146)			4 7%
Combined mortality (exclusive of cancer)			7 %

TABLE IX

Analysis of Operative Deaths

(Exclusive of Cancer Cases)

Acute Cases

No	Age	Sex	Pathology	Operation	Course and cause of death
1	40	F	Acutely inflamed gall-bladder stones, hemorrhagic pancreatitis	Drainage of gall-bladder and pancreas	Never rallied Died two days post-op with profuse biliary and pancreatic discharge
2	48	F	Perforated gall-bladder, stones, localized intraperitoneal abscess	Cholecystostomy and drainage	Almost moribund on admission Died 22 hours post-op
3	25	F	Acutely inflamed and distended gall-bladder, stone in cystic duct	Cholecystectomy appendectomy drainage	Went into shock on table, improved with stimulation, never rallied, died 36 hours post-op
4	25	M	Spontaneous perforation of common bile duct, pancreatitis, biliary peritonitis	Choledochostomy, drainage No stone found	Gradually failed with pancreatic asthenia, died 22 days post-op
5	45	F	Stone in common duct, spontaneous perforation and rupture of common bile duct biliary peritonitis	Choledochostomy and drainage	Died 48 hours post-op of peritonitis and toxic ileus
6	50	F	Perforated gall-bladder intra-abdominal abscess	Cholecystostomy drainage of abscess	Died 48 hours post-op with general peritonitis

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TABLE X

Analysis of Operative Deaths

(Exclusive of Cancer Cases)

Chronic Cases

No	Age	Sex	Pathology	Operation	Course and cause of death
1	40	F	Distended thick gall-bladder buried in liver, few small stones	Cholecystectomy and appendectomy	Died of surgical shock two days post-op
2	51	F	Large flabby gall-bladder, dense adhesions, hard pancreas	Cholecystectomy and appendectomy	Died two days post-op of renal insufficiency and anuria (no P S P done)
3	30	F	Thickened gall-bladder No stones, adhesions	Cholecystectomy	Ligature on cystic vessels slipped, much hemorrhage, op shock, pneumonia, died on 5th day
4	50	F	Thin walled gall-bladder, many stones	Cholecystectomy	Died 5th day post-op with myocardial failure following auricular fibrillation
5	61	M	Old thickened gall-bladder, atrophied, stone in common duct, long period of obstructive jaundice	Cholecystectomy, choledochostomy and drainage	Died 5th day post-op asthenia, hypostatic pneumonia, myocarditis
6	68	F	Thickened gall-bladder buried in adhesions, pyloric obstruction, ulcer duodenum	Cholecystectomy and gastrojejunostomy	No reparative power, wound never healed, asthenia, died 22 days post-op
7	31	F	Moderately thickened gall-bladder, no stones, anomalous vessels	Cholecystectomy	Anomalous vessel radicles, hemorrhage profuse, shock, died in 24 hours

TABLE XI

End Results of Follow-up Study

Patients discharged after operation as recovered or improved	166
Patients followed at regular intervals during 4 year period	71
<i>Good result</i> —No symptoms, no hernia, entirely well 48 cases associated with stone formation	56
<i>Fair result</i> —Partially relieved but with vague digestive disturbances, discomfort, painful and tender scars, etc (Equally divided between stone cases and those without stones)	8
<i>Poor result</i> —Complaining of same symptoms as before operation and incisional hernia in 4 cases (2 cases with stone, 4 without)	6
<i>Died</i> —Cancer of pancreas—cholecystgastrostomy (Died 1 year after operation)	1

Eight cases readmitted to hospital for secondary operation on common duct, appendix, ulcer of duodenum, or stomach, repair of hernia, etc

COMMENTS AND CONCLUSIONS

In this analysis several factors are worthy of special comment

It is noteworthy that at operation stone formation was present in 120, or about 65 per cent, of the total number of cases operated. In 108 X-ray studies, the presence of stone was demonstrable in only twenty-four patients, or about 22 per cent of those in which such examinations were made.

Malignant disease was found in eight patients and constituted 4 per cent of the total.

Obstruction of the common bile duct with jaundice was observed in ten cases or 5 per cent of the entire series. There was no instance of accidental injury to the duct system.

While in this series cholecystectomy was the operation of election for gall-bladder disease, cholecystostomy, or simple drainage operations, were done in eleven of the acute cases as an emergency measure. We feel that this simpler procedure should be more frequently utilized in the acute, bad risk patient, reserving the radical and complete operation for a subsequent time.

In the analysis of our end-results it may be seen that the patients who obtained the most permanent and complete relief from symptoms were those with cholelithiasis, that they sought relief because of repeated attacks of biliary colic or because of an acute episode characterized chiefly by severe right upper quadrant pain, not relieved by ordinary measures. At operation, in these cases, it was found that they were almost invariably associated with impaction of stone in the cystic or more rarely the common duct and that the underlying pathology was not primarily infectious in origin but due chiefly to mechanical and circulatory disturbances with resultant œdema, hemorrhage, hydrops or infarction. When actual infection was shown to be present it seemed to us to be a complication, or late result, rather than the primary lesion.

The cases, on the other hand, which were least satisfactory in permanent relief of symptoms were those not associated with cholelithiasis who sought relief, not because of severe pain or colic, but who presented that vague train of digestive disturbances which have been so often ascribed to chronic infection of the gall-bladder. In cases not exhibiting more definite pathological changes than slight fibrosis or involution atrophy and presenting this well known vague group of symptoms, we have come to believe that such gall-bladders should be less frequently sacrificed than has been the recent practice of many surgical clinics, and that the causes for such symptoms should be sought for elsewhere and corrected by means less hazardous and with better end-results than have followed the too frequent removal of this organ.

The term "cholecystitis," either acute or chronic, implies the presence of infection. Does it always portray an accurate picture of the most frequently encountered and predominant surgical lesions of the gall-bladder?

CLOSURE OF THE ABDOMEN WITHOUT DRAINAGE AFTER OPERATIONS UPON THE BILE TRACTS

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IN THE twelve years since we began to advocate the primary closure of the abdomen after operations on the bile tracts, the trend of surgical practice has gradually swung toward that direction. Many surgeons, however, still cling to the practice of routinely draining these wounds. In a recent article, Wangsteen concludes on the basis of a case of his own and from a number described in the literature, that the "so-called ideal cholecystectomy is not a safe procedure—that drainage after cholecystectomy is imperative, that it is a safeguard and does no harm." W. J. Mayo has closed tentatively, without drainage in a series of cases, but states that "a little drain is a comfort to the surgeon and sometimes a life buoy to the patient." In the European literature, too, there has been a reaction away from the routine use of the drain, but the majority of surgeons still follow the old practice of leaving drains or tampons in all cholecystectomy wounds. Moynihan writes, "There are surgeons who like to close the abdomen after removal of the gall-bladder, and there are surgeons who do not. I place myself with confidence among the latter. I never close the abdomen without a drain, though in the days of my adventurous youth I often did." Hartmann objects to extensive tampons and limits himself to small drains, but is afraid to relinquish them entirely. The veteran Korte writes, "He who is wise will stick to the drain," and Enderlen declared to the German Surgical Society, "I have been reared in the fear of God and the Peritoneum," and thinks primary closure is permissible only in carefully selected cases. This middle view, that the abdomen may and should be closed in the presence of certain well-defined and rigidly observed indications, is maintained by Haberer, Payr and others. Obviously, the conception as to what constitutes indications varies widely in the different clinics.

In our own work, we have been closing the abdomen without drainage in gall-bladder operations for over twelve years. We have increasingly widened our range of indications, and are strongly convinced of the safety and of the advantages gained in omitting the drain. We close our incisions after common duct work, and after trans-duodenal choledochotomy, as well as after simple cholecystectomy. We usually follow this practice in acutely infected cases as well as in chronic, relatively aseptic ones, and do not regard the spilling of bile or of duodenal contents in the field of operation a contra-indication. If there is uncontrollable oozing from the liver bed, a gauze pack is left in place, if in common duct operations, the accurate suture of the duct is

impossible, or if some other special contra-indication exists, we place a drain in the incision. Otherwise, we do not drain. We have closed primarily in 262 bile tract operations, and with one possible exception which will be described later, have yet to regret having omitted the drain. This report is based on 400 consecutive gall tract cases, special consideration being given to the question of drainage. Table I.

TABLE I

Group	Operations	Drained			Not drained			Total		
		Cases	Mortality		Cases	Mortality		Cases	Mortality	
			No	%		No	%		No	%
I	Simple cholecystectomy	29	1	3.45	204	2	0.98	233	3	1.29
II	Cholecystectomy plus common duct work	38	3	7.89	27	2	7.41	65	5	7.69
III	Cholecystectomy plus other major work	3	0	0.00	22	2	9.09	25	2	8.00
IV	Simple cholecystostomy	54	3	5.55				54	3	5.55
V	Cholecystostomy plus common duct work	7	2	28.57				7	2	28.57
VI	Cholecystostomy plus other major work	11	0	0.00				11	0	0.00
VII	Primary common duct work	10	5	50.00	2	0	0.00	12	5	41.66
VIII	Miscellaneous	4	2	50.00	7	1	14.27	11	3	27.27
	Totals	156	16	10.26	262	7	2.67	418	23	5.50

In Table I, are listed the 418 operations performed on 400 consecutive patients, with diagnosis of gall tract disease. For purposes of clarity, they are divided into eight groups on the basis of the type of operations done. It will be seen that cholecystectomy was done in 323 cases, sixty-five times with additional common duct work, and twenty-five times associated with some other major abdominal surgery. The appendix is usually removed as a matter of routine and is not included as additional "major" work. Of the 323 cholecystectomies, the wound was drained in seventy and closed primarily without drainage in 253 cases. Simple cholecystectomy with primary closure of the incision was done 204 times with two deaths, an average mortality of 0.98 per cent. One of these deaths was due to acute pancreatitis, the other to a pulmonary embolus on the day on which the patient was to have left the hospital. The average mortality in all of the cholecystectomized cases, including those with common duct or other major operative work was 3.39 per cent. It will be noticed that the percentage of fatalities is higher in the drained groups than in the not drained. The obvious explanation, of course, is that the severest and most difficult cases are the ones which most frequently required drainage. This explanation accounts, too, for the relatively high

DRAINAGE AFTER OPERATIONS UPON THE BILE TRACTS

mortality in the cholecystostomized cases. Thus, the gall-bladder has been drained seventy-two times with a total mortality of 6.94 per cent. In the group of simple cholecystostomy without other associated work there were three deaths in fifty-four cases. These represent for the most part, the poorest risk cases, jaundiced subjects, overwhelming infections, debilitated patients. Twelve cases are listed as primary common duct operations. They represent for the most part plastic procedures on the common duct, although a few cases of choledochotomy for stone where the gall-bladder had been previously removed are included. As is to be expected the mortality in this group was the highest. The common duct was operated upon in all eighty-four times in the series. Twelve of the twenty-three fatalities occurred in these common duct cases. In the last group eleven cases are listed as "miscellaneous." They comprise cholecyst-gastrostomy or cholecyst-duodenostomy because of carcinomatous obstruction of the common duct four cases, one case in which adhesions were broken up, one exploration in a case of congenital absence of the gall-bladder, one in an inoperable carcinoma of the gall-bladder, one in an acute suppurative hepatitis, one in an obscure jaundice of hepatic origin, one case of simple drainage of a biliary peritonitis, and one of abscess associated with recurrent carcinoma of the gall-bladder. There were twenty-three deaths in the entire series, giving a total operation mortality of 5.50 per cent, a patient mortality of 5.75 per cent. Table II.

TABLE II
Fatalities

Group	No.	Age	Pathology	Operations	Drain	Complications and course	Time
I	207	29	Cholelithiasis	Cholecystectomy	No	Unsuccessful convalescence Sudden death on day of discharge Pulmonary embolism	9 da
	294	49	Cholelithiasis	Cholecystectomy	Yes	Acute nephritis Uremia (Autopsy)	7 da
	390	43	Cholelithiasis, chronic pancreatitis	Cholecystectomy	No	Repeated attacks of acute pancreatitis with severe collapse, ileus and death Eventration	16 da
II	32	64	Cholelithiasis, common duct stone	Cholecystectomy choledochotomy	Yes	Nephritis	6 da
	88		Acute Cholecystitis with stones Common duct stone Acute cholangitis	Cholecystectomy choledochotomy	No	Clinically, death of pulmonary origin Autopsy not obtained	2 da

TABLE II *Continued*

Group	Case No	Age	Pathology	Operations	Drain	Complications and course	Time
II	261		Cholelithiasis, common duct stones	Cholecystectomy choledochotomy	Yes	General peritonitis Incision reopened, source not found Fluid contained no bile Suprapubic drainage	3 da
	286	41	Stricture of common duct from stones Jaundice "White Bile"	Cholecystostomy choledochotomy 1 month later Cholecystectomy choledochostomy Duct dilated	Yes	Hepatic insufficiency Hemorrhage Chronic pancreatitis Shock	2 da
	229	61	Cholecystostomy 3 weeks ago for acute G B Stricture of common duct from inflam or stone	Cholecystectomy choledochotomy Duodenotomy (Ampulla incised)	No	Peritonitis (Autopsy)	6 da
III	93	57	Previous cholecystostomy Cholelithiasis Uterine fibroid	Cholecystectomy Myomectomy and suspension, (sep incision)	No	Clinically a pulmonary death but no autopsy	2 da
	214	47	Acute cholecystitis Gastric ulcer Pyloric obstruction	Cholecystectomy Gastro-enterostomy	No	Obstruction at G-E opening Re-laparotomy and entero-anastomosis No peritonitis	2 da
IV	121		Acute cholecystitis	Cholecystostomy	Yes	Rupture of heart, sudden death (Autopsy)	1 da
	205	73	Acute gangrenous cholecystitis Jaundice	Cholecystostomy	Yes	Jaundice Senility	2 da
	324	33	Cholelithiasis Common duct stones Icterus gravis	Cholecystostomy	Yes	Jaundice Hemorrhage Anuria Term pneumonia	15 da
V	83	30	Cholelithiasis Common duct stone	Cholecystostomy Choledochotomy Duodenotomy	Yes		7 da
	289	27	Cholelithiasis Common duct stone Jaundice	Cholecystostomy Choledochotomy	Yes	Jaundice Hemorrhage Jaundice persisted Wound reopened, tubes filled with blood clot Death from cholema and hemorrhage (Autopsy)	9 da

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TABLE II *Continued*

Group	Case No	Age	Pathology	Operations	Drain	Complications and course	Time
VI	106	23	Stricture of common duct following cholecystectomy elsewhere	Choledochostomy 4 months later Plastic on common duct	Yes	Jaundice Cholemia Hemorrhage (Autopsy)	1 da
	274	56	Cholelithiasis Common duct stones Jaundice	Choledochostomy	Yes	Cholemia Oozing Death from hemorrhage	1 da
VII	245	31	Biliary peritonitis Stricture of common duct following cholecystectomy elsewhere Jaundice	Simple drainage several months later Plastic on ducts	Yes	Jaundice Uncontrollable oozing Repeated blood transfusion Death from hemorrhage	8 da
	308	25	Operative damage to common duct Jaundice	Choledochostomy 3½ mo later Plastic repair of ducts	Yes	Jaundice Asthenia Hemorrhage Abdomen re-opened on day of death for bleeding	4 da
	320	41	Cholelithiasis Common duct stones Jaundice "White Bile" Pancreatitis	Choledochostomy	Yes	Jaundice Hepatic insufficiency Pancreatitis Hemorrhage	1 da
VIII	188	54	Previous cholecystostomy Cholecystitis Cirrhosis of liver Jaundice of obscure hepatic origin	Exploration (findings same)	Yes	Jaundice Cirrhosis Gradual wasting with persisting jaundice Death following simple exploration	1 da
	157	63	Carcinoma of hepatic flexure of colon Cholelithiasis	Cholecyst-gastrostomy Ileo-colostomy	No	Suppurative parotitis Septic infarcts in lung Multiple gastric ulcers (Autopsy)	42 da
	307	57	Previous cholecystostomy Carcinoma of gall-bladder Recurrence with infection	Simple drainage	Yes	Immediate post-operative course favorable Thrombophlebitis with death two days later	7 da

In Table II are listed all of the fatalities occurring in the series, with a statement giving as accurately as possible, the cause of death in each case. From the two foregoing tables, several salient observations are to be noted. The importance of early operation—that is, while the pathologic changes are still limited to the gall-bladder—is clearly indicated. Thus, the mortality rate in the simple cholecystectomized patients was 1.29 per cent as against a mortality of 14.28 per cent in all of the cases requiring work on the common duct. And of the three deaths occurring in the simple cholecystectomy group, the one from pancreatitis (Case 390) can scarcely be included among the early cases. The safety of closing the abdomen without drainage is also brought out. Sixteen of the twenty-three deaths were in drained cases (10.27 per cent mortality) while only seven (2.68 per cent mortality) occurred in the non-drained ones. This difference, as mentioned before, is largely due to the fact that the most difficult and poorest risk cases are the ones most often requiring drainage. Nevertheless, it emphasizes the relative safety of primary closure. Among the non-drained fatalities, there was only one death from peritonitis (Case 229). This is the single instance referred to above in which it might have been better to drain. The patient, a woman of sixty-one, came under observation during an attack of acute cholecystitis. A simple cholecystostomy was done and she reacted well, although there was an unusual degree of shock for the limited amount of work done. Three weeks later, the gall-bladder was removed, the common duct incised and sounds passed in both directions. Obstruction to the sound was encountered in the region of the ampulla and the duodenum was opened. The ampulla was incised, permitting the sounds to be passed through what appeared to be a stricture from previous inflammation or stone. Peritonitis developed terminating fatally on the sixth day. The diagnosis of peritonitis was confirmed at autopsy. While it is doubtful whether the presence of a drain would have altered the outcome in this case since it did not prevent those deaths from peritonitis in the drained cases, the wisdom of the primary closure may be questioned. In Case 88 in which the gall-bladder was removed, the common duct incised, freed of stones sutured, and the abdomen closed without drainage, all in the presence of acute infection plus jaundice, the error in judgment was probably in doing too much rather than in omitting the drain. With these possible exceptions there has never been occasion to regret having closed without drainage in gall tract operations and the procedure in our hands, has proved to be safe and satisfactory.

It is to be emphasized that in the group of over two hundred simple cholecystectomies closed without drainage, only one death, that from pancreatitis was of abdominal origin and it is difficult to associate this fatality with the question of wound drainage. In the entire series of 262 cases of all types which were closed without drainage, there was only one in which death was definitely due to peritonitis.

The advantages gained for the patient by omitting the drain after gall tract operations are for the most part obvious, and have been too often

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described to require discussion. In comparing the post-operative course in drained and non-drained cases, Coventry found that the former had much more pain, particularly pain radiating to the shoulder, more post-operative tympany, nausea and vomiting, more elevations of the pulse and temperature. The stay in bed after primary closure is shortened, as is also the stay in the hospital and the entire period of convalescence. The patient is spared the pain, the shock, and frequently the anæsthetic required in removing the drains. The escape of bile from the incision, so often observed in drained cases, and so often mentioned as an argument against the primary closure does not occur when there is no drain. The presence of a foreign body in the wound leading directly to the outside, certainly predisposes to infection from without and interferes with the body's mechanism for the combating of such infections. The development of incisional hernia is favored by this almost inevitable infection. Willis Buchbinder, and others have demonstrated that the formation of post-operative adhesions, with their attendant discomforts and disabilities is promoted by the pressure of the drain, and von Haberer calls attention to the greater likelihood of thrombosis and embolism and the possibility of secondary hemorrhage because of the drain.

Since we have gradually widened our range of indications for closing without drainage, an analysis of 100 consecutive recent cases was made, to see in what proportion of current cases drainage is omitted. The results are listed in Table III.

TABLE III
Analysis of 100 Consecutive Recent Cases

Group	Operation	Drainage	Cases	Average post-operative stay in bed	Average post-operative stay in hospital	Deaths
I	Simple cholecystectomy	No drain Drained	66 4	7.01 days 10.25 days	13.45 days 21.75 days	1 (No. 390)
II	Cholecystectomy plus common duct	No drain Drained	9 6	15.66 days 7.67 days	24.33 days 18.17 days	
III	Cholecystectomy plus other major work	No drain Drained	6 0	8.00 days	16.17 days	
IV	Cholecystostomy		4	23.67 days	38.67 days	1 (No. 324)
VII	Primary common duct work	No drain Drained	1 2	12.00 days	16.00 days	2 (Nos. 308 & 320)
VIII	Miscellaneous	No drain Drained	1 1	3.00 days	13.00 days	1 (No. 307)

From this table it is seen that the gall-bladder was removed in ninety-one of the 100 cases, seventy times without other work, fifteen times together with operative work on the common duct, and in six associated with some other major surgical procedure. Of the seventy simple cholecystectomies, four

were drained. One of these was an acute case with considerable cholangitis, and the cystic duct stump was not ligated, in two the drain was inserted because of persistent oozing from the liver bed and in the fourth, there was an acute gangrenous gall-bladder which ruptured during the removal causing considerable soiling with highly infectious material. It will be noted that post-operative stay in bed and the stay in the hospital were considerably shorter in the non-drained cases. The average stay in bed in this group was seven days. This is interesting in light of von Haberer's repeated warning that when these incisions are drained, the drain must be left in for a minimum of twelve days. According to this, the majority of our non-drained cases are discharged from the hospital before the others may be relieved of their drains. In those cholecystectomized cases in which the common duct was also opened, nine were closed without drainage and six were drained. Curiously, the convalescence here was more rapid in the drained cases, the explanation being that recovery in several of the non-drained group was delayed by complications of one type or another, in no case abdominal, and in so small a series of cases, the *average* length of the post-operative course is materially increased. Of the entire 100 cases, eighty-three were closed tightly, without drainage, and seventeen including the cholecystostomized ones were drained.

The chief argument advanced against primary closure is that of danger from bile leakage. That such leakage occurs when the wound is drained, is common knowledge, and the assumption is that if the incision had not been drained, a serious or, perhaps, fatal biliary peritonitis would have ensued. There is evidence, however, to indicate that such bile leakage occurs much less often in non-drained cases than in drained ones, and which would seem to suggest that the drain itself is a factor in causing the escape of bile. Blalock, reviewing all the gall-bladder cases operated upon at Johns Hopkins Hospital over a period of thirty-five years, reports that 38 per cent of the cholecystectomies (the incision in all cases had been drained) drained bile after the operation. Holman, observed bile drainage twenty-two times in sixty-eight cases and Walzel and Wiesentius found ten in ninety-nine simple, drained cholecystectomies in von Eiselsberg's Clinic. Vigyazo places the incidence of such bile flow at approximately 10 per cent. Bile leakage in non-drained cholecystectomy, on the other hand, is a rare occurrence. Isolated cases have been reported here and there, and in many of these gross error in technic probably played a rôle. In our own work, we have never had to reopen the abdomen because of insufficiency of the cystic duct stump. We have had occasion to evacuate biliary accumulations from the peritoneal cavity in two cases, both of which had been operated upon elsewhere. In one case, there had been gross injury to the hepatic duct with consequent escape of bile. In the other, the gall-bladder had been removed and the abdomen closed without drainage. There were stones in the common duct, however, which had been overlooked, and which may have caused obstruction of the duct. We were not able to discover whether there were any other gross technical errors which might have accounted for the choleperitoneum. Accidents such

as these can scarcely be laid to the omission of the drain, and it raises the question whether some of the reported incidents of bile accumulation may not have been due to some similar cause

That the drain itself may be the source of bile leakage in uncomplicated cases is claimed by Stettin and others, and has also been experimentally demonstrated. Vigyázo and Schulhof removed the gall-bladder in a series of animals, leaving the cystic duct stump wide open. The animals remained well and at re-laparotomy there was no evidence of peritonitis or bile accumulation. The end of the cystic duct was firmly closed off by adhesions from the omentum and surrounding viscera. In other animals, the top of the gall-bladder was cut off and in others the gall-bladder was split longitudinally and sewed inside-out. In these experiments, too, the abdomen was closed without drainage, the animals remained in good health, and re-operation revealed walling-off the gall-bladder region without evidence of bile accumulation. In subsequent experiments the liver was extensively injured, and the abdomen closed without drainage in some instances, with drains or tampons in others. Those closed primarily all remained well. Those tamponed or drained, became icteric and re-operation showed that healing was interfered with by the presence of the drain.

It has also been claimed that bile leakage may be due to aberrant ducts running directly from the liver to the gall-bladder, or to dilated subcapsular ducts which are torn in the removal of the gall-bladder (Haberland, Wazel). Holman described three cases with anomalous branches of the biliary ducts, which he felt provided further justification for drainage after cholecystectomy. Moynihan states that the presence of accessory ducts, so fine that they escape notice, requires drainage in 15 per cent of the cases. We have personally seen a spurt of bile from a dilated biliary duct in the liver bed, which had to be ligated. These occurrences must be rare, however, as is evidenced by the fact that bile leakage does not occur after primary closure. And should such an anastomic variation be present it is reasonable to assume that, in the absence of a drain, the leakage is prevented by adherence of omentum and bowel, such as occurred in the experiments of Vigyázo. This last named author states that leakage due to such anomalies is rare. He summarizes by saying that the source of the post-cholecystectomy bile flow is only rarely due to insufficiency of the cystic duct stump. The frequent "benign" cholerrhagia, he attributes to lesions of the liver bed as a result of the shelling out of the gall-bladder, or to tears of the liver parenchyma from too rough handling. He considers the tampon an important factor in maintaining the flow, by interfering with the biologic agents concerned in the healing of such lesions, and by interfering with the adhesion of the omentum over the defect.

Granting that, in an occasional case, because of some unusual anatomic anomaly, or a gross technical error, bile may escape from the ducts and accumulate in the peritoneal cavity, it has often been shown that such a choleperitoneum is relatively innocuous. That the highly infective contents of gangrenous gall-bladder, which goes on to spontaneous perforation may lead

to a serious peritonitis, is of course obvious. The contents of the ordinary, chronically infected or calculus containing gall-bladder, however, have often been found sterile. And when organisms are present, they are usually of low virulence. It has even been found (Ehrhardt) that bile in the peritoneal cavity protects against bacterial peritonitis, and it is probable that the bile in the gall-bladder depresses the virulence of the contained organisms. Wangsteen presents a representative review of literature regarding the danger of bile in the peritoneal cavity. He cites numerous cases of traumatic rupture of the bile tracts with large intraperitoneal accumulations, which were well borne for many days or weeks, and which often yielded to simple puncture or incision. He states further that "a number of experimental investigators have concerned themselves with this problem, and with one exception have all concluded that sterile bile may be present in the peritoneal cavity without harm." In his own experiments, after ligating the common duct and cutting a hole in the fundus of the gall-bladder, the animals died very quickly. As he points out, however, there are several essential differences between such conditions and those prevailing in the human subject at operation. He attributes death to the toxic action of the absorbed bile, stating that the bile in the dog contains much more taurocholic acid, while human bile contains relatively more of the less toxic glycocholic acid. The diversion of all the bile from the intestinal tract is undoubtedly also a factor, accounting for the delayed death in untreated cases of choleperitoneum.

We have had occasion to observe two cases of intraperitoneal bile accumulation within the past few years, both of which were due to gross operative accident, and both of which suffered relatively little harm from the presence of the bile. In both cases, drainage gave complete relief.

CASE 275—Mrs. O. W., age fifty. The patient gave a history of gall-bladder attacks extending over a period of one year, with slight jaundice accompanying one severe attack. She was operated upon elsewhere, December 2, 1924, cholecystectomy was done and the abdomen closed without drainage. After operation, she continued having abdominal pain and vomiting, became much worse a week later, and jaundice appeared. The stools were colorless, the urine very dark. These symptoms persisted until about January 1, 1925, when an accumulation of fluid developed beneath the incision. This was evacuated, symptoms subsided and jaundice disappeared. On January 6, the drainage stopped, pain in the abdomen reappeared, and persistent vomiting of greenish fluid again developed. The patient was then brought to our service at Wesley Hospital. On admittance, her temperature was 99, pulse 90, and there was a moderate degree of jaundice. The entire abdomen was greatly distended and tender, and there was flatness and a fluid wave in the right upper quadrant. Peristalsis was diminished over the entire abdomen, and there was a leucocytosis of 14,000. Diagnosis of "Injured common duct with localized accumulation under tension in right hypochondrium and a general biliary peritonitis," was made and operation performed. The old incision was reopened, and a walled-off accumulation of bile in the epigastrium was evacuated. There was also a large accumulation of bile-colored fluid in the free peritoneal cavity, estimated at about 3 litres, and considerable in the pelvis. The peritoneal surfaces were slightly reddened and there were occasional fibrinous deposits. The fluid was aspirated, the wound closed with drainage, and counter drains placed in a second suprapubic incision. The patient felt much better immediately after regaining consciousness, and convalescence was without incident.

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Radical operation was done two and one-half weeks later. There were dense adhesions everywhere, and a bile-stained peritoneal exudate. The common duct was exposed, found to be enormously dilated, to a diameter of an inch or more. The common duct was incised, a large quantity of bile and several small stones escaped. Several more stones were removed, and male urethral sounds were passed in both directions. The source of the bile leakage was not discovered. A large accumulation of bile-colored fluid, estimated at about a quart, was evacuated from the right kidney fossa and a smaller accumulation in the infra-hepatic region was also drained. The abdomen was closed with drainage. Her recovery was entirely uneventful, except for the development of an incisional hernia, which has since been repaired.

CASE 245—Mrs. T. L., age thirty-four, was operated upon elsewhere on February 16, 1924, for gall-stones, gall-bladder and appendix were removed, and the abdomen was closed without drainage. She continued to have pain and slight irregular elevations of temperature after the operation. The stools were acholic, and there was gradually increasing distention of the abdomen. When seen ten days after operation, the patient was in good general condition, temperature was 100, pulse 100. The abdomen was distended, peristalsis diminished, stools acholic and there was a moderate degree of jaundice. On February 28, the abdomen was reopened. A large quantity of bile was found in the peritoneal cavity, and a small incision was seen in the right hepatic duct. The fluid was evacuated, drains inserted and the abdomen closed. The patient was discharged from the hospital, March 13, in good condition, and with only slight drainage from the incision.

The drainage persisted for about three months, then the sinus closed. About one week later jaundice reappeared. Patient was readmitted to the hospital, definitely icteric. After preliminary preparation with intravenous calcium chloride injections, the abdomen was reopened on July 12. Stricture of the hepatic duct was found, close to its entrance into the liver. The stricture was dilated gradually until No. 18 male sounds were passed. A small rubber tube was introduced into the hepatic duct toward the liver, and its end brought through the abdominal incision. Cigarette drains were placed and the incision closed. There was free bleeding throughout the operation, with a gradual fall in blood pressure which necessitated blood transfusion. The oozing persisted despite repeated transfusions, condition became gradually worse, and the patient died eight days after the operation.

These two cases are cited as instances of intra-peritoneal bile accumulations, both of which were due to gross technical operative error, and in both of which, the presence of a relatively large amount of bile in the abdomen was well tolerated. In the one case a massive accumulation had apparently been present for a month or longer without seriously impairing the patient's condition or producing severe manifestations. At operation, evidences of very mild peritoneal reaction were present, and the condition cleared up promptly following simple evacuation and drainage. In the second case, the patient was up and about despite an increasing accumulation of bile in the peritoneal cavity. Here, too, simple evacuation and drainage brought prompt recovery. The patient's ultimate death following operation for stricture of the hepatic duct was, of course, in no way associated with the previous choleperitoneum.

There is one other fallacy in the treatment of cholecystectomy wounds to which we have once before called attention. Many operators are willing to close the abdomen without drainage if the cystic duct stump can be adequately buried, and innumerable procedures have been devised and advocated for concealing the end of the duct somewhere behind the peritoneum. This we consider to be wrong in principle. The capacity of the peritoneum for pro-

protecting against infectious and irritant substances has often been demonstrated, and the peritoneum is usually able to take care of whatever leakage may possibly take place from a cystic duct stump. The escape of such substances into retroperitoneal spaces, however, where the tissues have infinitely less resistance would be much more serious. In the technic employed by us, the cystic duct is carefully isolated, clamped, divided, and tied with a single catgut ligature. A separate ligature is usually placed on the cystic artery. No attempt is made to bury the stump of the duct behind the peritoneum nor to cover the raw surface in the liver bed. Whatever exudation takes place, be it bile or blood, can flow unhindered into the peritoneal cavity, where it is disposed of with least harm to the organism.

SUMMARY

1 Report is based upon 400 cases operated upon because of bile tract disease, special consideration being given to the question of abdominal wound drainage.

2 In 262 of the cases, the abdomen was closed without drainage, including twenty-nine cases in which the common duct was opened and sutured, and twenty-two cases requiring other major surgical work in addition to that on the bile tracts.

3 Of the seven deaths occurring in these 262 cases, only one could definitely be ascribed to peritonitis.

4 There have been no gross accidents resulting from the primary closure, and with the one possible exception we have yet to regret having closed an abdomen without drainage.

5 There were two fatalities in 204 simple cholecystectomies closed without drainage, only one of which was of abdominal origin. Death in this case was due to pancreatitis and was unassociated with the question of wound drainage.

6 The frequent bile drainage occurring after operations in which the incision is drained, is not seen if the drain is omitted.

7 Omitting the drain, minimizes the post-operative discomforts, reduces the incidence of infection-hemia, and shortens the post-operative stay in bed, stay in hospital, and period of convalescence.

8 On the basis of the above reported material, we are convinced of the safety and desirability of closing the abdomen without drainage after operations on the biliary tracts, and urge its wider application.

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HIDDEN PERFORATION OF THE GALL-BLADDER

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FROM THE LANFNAU CLINIC PHILADELPHIA PA

THIS condition was called to my attention at the post-mortem of a woman fifty years of age, whose chief complaint was vomiting, present for two years, and becoming progressively worse. There was neither pain nor discomfort. She had lost eighty pounds in weight in one year. On physical examination the stomach was found to be enlarged and to contain fluid. No masses were noted in the abdomen and there were no areas of tenderness elicited. A provisional diagnosis was made of pyloric obstruction from carcinoma of the stomach. At operation a hard, firm, nodular mass about eight centimetres in diameter was found at the pylorus which could not be delivered so a posterior gastro-enterostomy was done. The mass was thought to be carcinomatous. The patient died a few days later and at the post-mortem examination the mass was found to involve the pylorus, the first portion of the duodenum, the gall-bladder, and the adjacent part of the liver, it could not be separated due to the thick adhesions. On sectioning the mass was seen to be not a malignant tumor but an ulceration of the gall-bladder with perforation due to multiple stones. Two stones were found obstructing the pylorus and the first part of the duodenum, one between the duodenum and gall-bladder and a fourth stone in the gall-bladder, all being tightly bound down by dense adhesions.

Perforation of the gall-bladder is a comparatively rare condition. In this clinic from October, 1920, to October, 1927, there were 1270 gall-bladder cases operated, of which sixteen, or 1.2 per cent were perforated. McWilliams (cited by Blaudstein¹) reviewed a total of 3180 operations on the biliary tract and encountered perforation in twenty-nine, or 0.9 per cent. Blaudstein also reports Karullon's figures from an analysis of 6114 autopsies in which 572 cases had gall-stones, three, or 0.5 per cent, of which had perforated.

The condition occurs more frequently in women than in men, probably due to the fact that gall-bladder disease affects the female more often than the male. Of the sixteen cases of perforation in this clinic, twelve were women and four were men. The majority of these cases were over fifty years of age, the oldest being seventy-four and the youngest twenty-seven.

We have found only three cases in which perforation followed the first attack of abdominal pain. The duration of these symptoms varied from twenty hours to six days. The other cases had had many attacks and the length of time from the first attack to the time of perforation was from five months to nine years. Most of the cases developed their first symptoms between the ages of forty and fifty years.

The most common symptom is pain in the right hypochondriac region,

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which may or may not radiate to the scapula and right shoulder. The next most common symptom is epigastric pain, occasionally accompanied by vomiting. Jaundice is rarely present. Indigestion was the chief complaint in one patient and vomiting in one. At operation stones were encountered in eleven, adhesions in five, pus in six, bile in the abdominal cavity in three, gangrenous



FIG. 1.—Openings in gall bladder and duodenum due to rupture of gall bladder into duodenum. Shows position of stones.

gall-bladder in one case, pyloric obstruction in one, fistula between the gall-bladder and colon in one, and rupture of the gall-bladder into the abdominal wall in one case.

A correct pre-operative diagnosis was made in one case. In the others the diagnosis was gall-bladder disease four, acute appendicitis two, abdominal tumor one, pyloric obstruction one, chronic calculous cholecystitis with empyema one, perforation of intestines with peritonitis one, five not diagnosed.

The operative diagnoses were as follows:

Chronic calculous cholecystitis with perforation seven, acute calculous

cholecystitis with perforation two, perforation with gangrene one, empyema of the gall-bladder with rupture two, acute suppurative cholecystitis with perforation one, acute ulcerative calculous cholecystitis one, rupture of the gall-bladder into the abdominal wall one, carcinoma of the pylorus one In

- this last case (the one referred to at the beginning of this discussion) the correct diagnosis was made at autopsy

Cholecystectomy was done in ten cases with two deaths, cholecystostomy with drainage of the surrounding region in two with one death, choledochostomy one, this is included in one of the fatal cases of cholecystostomy, incision and drainage was done in two cases with one death, posterior gastro-enterostomy in one case followed by death Postmortem examination was made in this and in one other case



FIG 2 —Stones from ruptured gall bladder

Perforation may occur into any one of several regions depending upon the etiology and rapidity of the process. Acute perforation usually takes place into the free peritoneal cavity, for here nature has not had sufficient time to wall off the gall-bladder with adhesions. The process is usually due to ulcerative cholecystitis, the colon bacillus, typhoid bacillus, and streptococcus being the most common organisms found. Stones are not so often found as in the more chronic cases. Trauma is also a factor, but is exceedingly rare due to the protection of the gall-bladder anatomically. Alexander² reports one case due to trauma in 1000 cases of gall-bladder disease and this was due to a gunshot wound. There is usually present a distended and diseased gall-bladder.

Subacute and chronic perforation may take place into the small intestine, pylorus, stomach, colon, occasionally into the liver substance and very occasionally a stone may work its way through to the surface of the body.

When the stones penetrate the alimentary canal they usually cause intestinal obstruction. Surgical intervention is necessary as a rule but at times the stone passes spontaneously. Courvoisier's³ statistics (cited by Deaver and Ashhurst) show that the site of impaction is in the duodenum and jejunum in 21.4 per cent, ileum 65 per cent, ileocaecal valve in 10 per cent and the sigmoid flexure in 2.4 per cent. I have found four cases including our own in which the obstruction was at the pylorus.⁴

The mortality of perforated gall-bladder is very high. Theoretically this should not be so where perforation occurs into the abdominal cavity in

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view of the excellent protection given the gall-bladder by the surrounding anatomical structures, the parietal peritoneum, the under surface of the liver, the transverse colon, and the omentum all tending to prevent the foreign material from spreading and thus limiting the resulting peritonitis. Practically, however, this is not borne out, for the patient usually has had several gall-stone attacks and believing this to be a similar attack refuses operation. Thus perforation of the gall-bladder becomes one of the most fatal forms of perforation. The records of the Lankenau Clinic show a mortality of 43 per cent. Gossett, Desplas and Bonnett⁵ in analyzing 111 collected cases of perforation of the gall-bladder into the abdominal cavity, find a mortality of 52.2 per cent. Bennett,⁶ in 3064 cases of intestinal obstruction reports twenty-eight cases of intestinal obstruction due to gall-stones with a mortality of 50 per cent.

Diagnosis is very difficult and is seldom made until the abdomen has been opened, due to the rarity of the condition and the lack of pathognomonic signs. The acute perforation into the free peritoneal cavity is most frequently mistaken for perforated gastric ulcer or sometimes for a high lying appendix. The true condition is recognized when the bile-tinged peritoneum or peritoneal exudate is seen. In the subacute and chronic perforation there is often an antecedent history of gall-bladder symptoms and the presence of a more or less hard movable mass that will lead one to suspect the condition. In pyloric obstruction, as in our case, it is often mistaken for carcinoma of the stomach for the symptoms simulate this condition very closely. In obstruction in other parts of the intestinal tract the only aid is a previous history of gall-bladder disease. This latter condition is very rare. Bennett⁷ collected only twenty-eight cases in 3064 cases of obstruction (0.9 per cent.).

CONCLUSIONS

1 Perforation of the gall-bladder is comparatively rare, occurring in about one per cent. of diseased gall-bladders.

2 There are no pathognomonic symptoms but a careful history in which previous gall-bladder attacks have been present should lead one to suspect the existing condition. The exact diagnosis is rarely possible before operation but the nature of the condition should lead one to explore the upper abdomen.

3 The treatment is early surgical intervention, the procedure depending upon the age, condition of the patient and condition of the gall-bladder, but cholecystostomy with drainage of surrounding area seems the method of choice.

4 The mortality is about 50 per cent. and can be decreased only by early diagnosis and early treatment.

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LATE INTESTINAL STENOSIS FOLLOWING STRANGULATED HERNIA

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LATE intestinal stenosis following strangulated hernia has received little consideration in the American surgical literature. The observation of this condition five times in the last three years has therefore prompted us to briefly review the subject and to report these cases.

In short, the history of one of these cases is as follows:

A patient is operated upon for strangulated hernia. The intestine is found badly compromised but apparently viable and is replaced. At first everything goes well. There are no signs of peritonitis or intestinal obstruction. After a varying, free interval, ranging from weeks to months, the patient develops severe, colicky abdominal pain. The picture of an incomplete, mechanical ileus then supervenes, which demands further operative intervention. Laparotomy, at this time, reveals as the cause of obstruction either (1), an area of tubular stenosis due to fibrosis of part or all of the strangulated loop, or (2), an annular stricture corresponding to the zone of intestinal constriction at the neck of the sac.

Pathology—In the *early* stages of strangulation, the changes in the wall of the affected loop are venous stasis, oedema and a certain degree of hemorrhagic extravasation. Relief of the constriction at this time will result in a complete return to normal.

The *advanced* stages of strangulation are characterized by two features: firstly, a progressive devitalization of portions of the affected gut, and secondly, the development of permanent interference with circulation, due to thrombosis of the vessels in the intestinal wall or in the smaller mesenteric radicles. These are the cases that will undergo perforation even after the constriction is relieved.

There is an *intermediate* stage, however, in which though complete devitalization does not occur, the pathological changes at the time of operation are so advanced, that relief of the strangulation will no longer permit of a return to normal. In such cases, late intestinal stenosis may result.

To understand the pathogenesis of this last named condition the histological changes in a strangulated loop must be more closely considered. A study of these indicates that the different layers of the intestinal wall exhibit different degree of sensitivity to interference with their blood supply. Numerous post-mortems and the examination of resected specimens have

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shown that if the condition has progressed sufficiently for necrosis to occur, areas of the mucosa are the first to be involved, with the formation of ulcers. The muscular layers are next involved. The connective tissue elements, both submucosal and subserosal maintain their viability longest. When the stage of mucosal gangrene is reached, thrombosis in some of the smaller radicles of the affected loop are already present. These are important as they result in a permanently diminished blood supply to the affected part. This diminished vascularity interferes with the regenerative potentialities of the mucosa, which are normally very great. In fact, Schloffer,¹ years ago, demonstrated that experimental excision of even extensive areas of mucosa was followed by regeneration, and that intestinal stenosis or stricture could

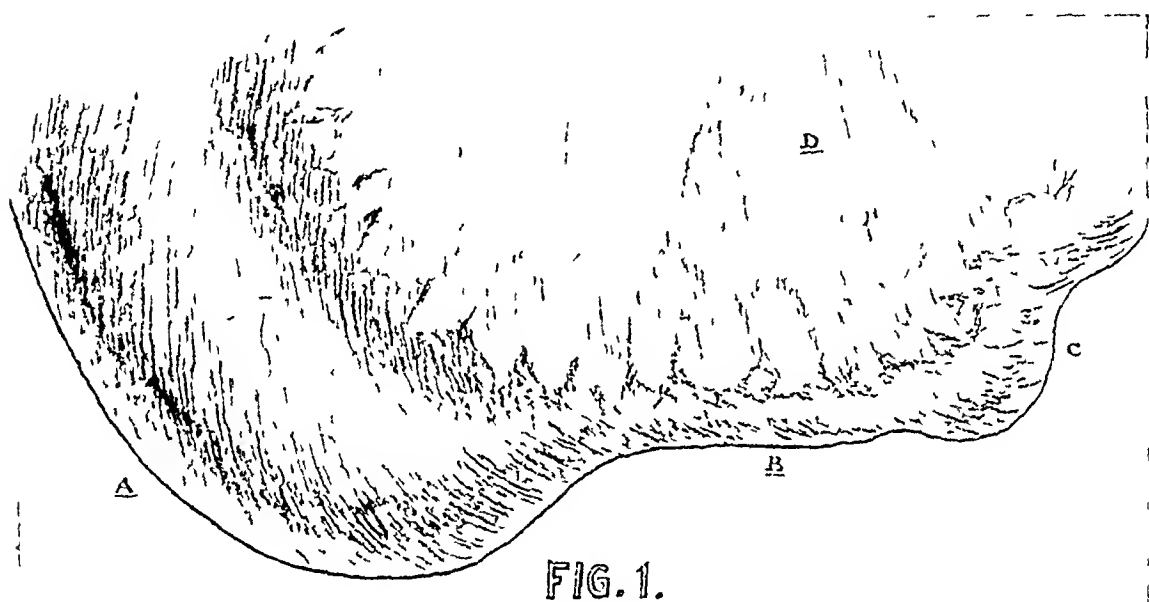


FIG. 1.—Semi diagrammatic sketch of the specimen in Case IV (Drawn by Dr. J. B. Stenbuck.)
 A The greatly dilated proximal loop B The area of stenosis C Distal collapsed intestine
 D Thickened mesentery of the affected segment

be experimentally produced only by interference with the blood supply of a given segment.

The other important factor in the final development of a fibrotic stenosis is infection. The bowel denuded of its protecting mucosal coat, and its resistance lowered by the diminished circulation, is invaded by intra-intestinal organisms. An inflammatory granulation tissue is formed which at first produces hypertrophic obstruction of the intestinal lumen and later undergoes fibrotic changes causing a scar tissue stricture. It must be remembered that in the small intestine there may be pathological narrowing without any clinical manifestations. Haasler³ has reported a few cases in which fibrotic small intestinal stenosis was an incidental finding in patients dying of other causes. It had apparently given rise to no symptoms during life.

The changes at the intestinal grooves ("Schnülfurche"), due to the direct constriction by the edges of the hernial ring, deserve a word for themselves. Hoffmann² in a study of fifty-six resected specimens, showed that the histological changes at these points were similar to, but occurred

earlier and were more marked than those present throughout the rest of the affected loop. At these zones, the *mucosa* is again the first to undergo necrosis, the *serosa* apparently not being involved until late, in spite of the direct pressure upon it.

When the changes as outlined above affect the entire loop of strangulated gut, a remarkable picture is finally produced (Fig 1). The greatly dilated bowel, proximal to the obstruction, terminates abruptly in a narrow thick-walled, firm, rigid tube from two to five inches in length, and one-half to one-quarter the diameter of the normal bowel. The mesentery of the involved portion is thickened fibrotic and contains numerous enlarged glands, so that the condition may be mistaken for a local tuberculous process or

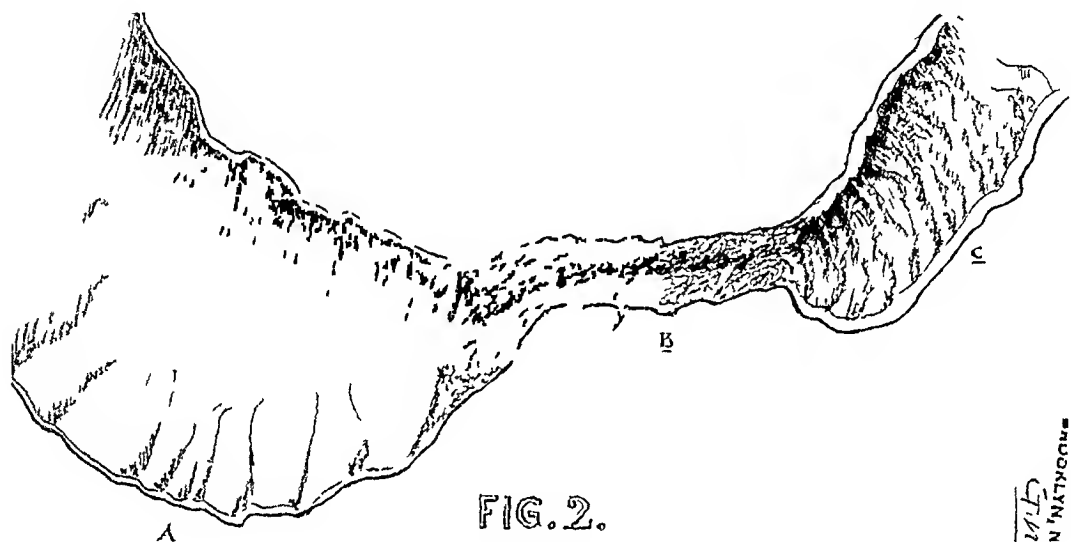


FIG 2—See legend under Figure 1

even malignancy. Distally, this area is again sharply demarcated from normal small intestine. There is a tendency for the involved segment to become adherent to the intestine immediately proximal and distal to it, producing an "S"-shaped coiling. When opened, the lumen of the stenotic portion is found greatly narrowed, at times barely admitting a medium-sized probe. It is lined by granulation tissue with scattered patches of hypertrophic mucosa. In the earlier stages mucosal ulceration in various stages of healing may be present (Case V).

When the changes have occurred only at the *constriction grooves*, an annular hypertrophic stricture denuded of mucosa is found. It is most apt to occur at the proximal constriction zone, but at times both are involved with the formation of a double stricture.*

Microscopically, in both the tubular and annular forms the mucosa is absent except for isolated hypertrophic patches, and the submucosa is replaced by a hypertrophic inflammatory granulation tissue. The muscu-

* Since the completion of this article, two cases of annular stricture have been reported by Eising, in the American Journal of Surgery.

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laris mucosæ is disrupted. There is marked inflammatory, subserosal thickening and varying degrees of fibrosis in the muscular layers.

Symptoms—In the majority of cases there is a free interval after operation of at least two or three weeks. The most frequent time for the development of symptoms is in the third or fourth week. Many cases, however, are symptom free for a considerably longer period, extending over months and in some of the reported cases, even years. Premonitory symptoms of diarrhoea or intestinal bleeding due to secondary sloughing of compromised areas may occur. Typi-

cally, however, the first complaint is of paroxysmal attacks of severe, generalized, colicky abdominal pain. This apparently bears a definite relation to the ingestion of food and in many instances is so constant that the patients voluntarily starve themselves. As the obstruction is in the small intestine, and in the beginning incomplete, there is passage of stool and flatus, a fact which is apt to obscure the sinister significance of the complaint. If the patient is seen during an attack of pain, visible peristalsis and borborygmus may be detected.

The symptoms usually become progressively worse with the development of the classical picture of an incomplete small intestinal obstruction.

If the obstruction is not relieved, the patients go rapidly down hill, partly from starvation, partly from chronic toxic absorption, probably due to bacterial and chemical decomposition in the obstructed loops. This is especially exemplified in Case IV, reported below, where a severe anemia, resembling pernicious anemia, developed very rapidly. At autopsy in this case, hepatic changes similar to those occurring in a severe toxemia were found. Incidentally, the development of severe anemia resem-



FIG. 3.—Microscopic section of involved intestine in Case IV. 1 The normal mucosal structure is gone. At points the intestine is devoid of epithelial lining. 2 The muscularis mucosæ is disrupted and the submucosa shows an inflammatory infiltration.

bling the pernicious type, has been reported in cases of small intestinal stricture by Meulengracht and others

The occurrence of attacks of severe abdominal colic, occurring in a patient in whom at the primary operation the intestine was found badly compromised, should immediately bring to mind the possibility of this condition. One should not be misled by the passage of gas or stool, or the absence of visible peristalsis, which in stout people may be difficult to detect.

The X-ray is of great value in diagnosis. At times, very important information may be obtained from an ordinary plate without the ingestion of barium, especially if there has been vomiting, or food has been withheld. The dilated loops of gut may then be well visualized because of their gaseous distention. If this examination is not productive of much information, recourse may be had to a small quantity of a barium mixture. The danger of converting an incomplete obstruction into a complete one by the barium must be borne in mind. The X-ray will show the typical picture of a partial small intestinal obstruction.

Treatment—Operative intervention should be undertaken early and should consist either of resection of the involved portion of the gut or of a short circuiting entero-anastomosis. If resection is performed a lateral anastomosis is preferable to an end to end, because of the great disparity in the diameter of the proximal and distal loops. In the presence of numerous adhesions, or when the patient is in poor condition, entero-anastomosis is the preferable mode of procedure. It was performed in three of the cases reported below, with excellent results.

In those cases where the obstruction has been due to an annular constriction, a plastic operation similar in principle to the Hemeke-Mikulicz pyloroplasty, has been used by some. In the presence of ileus with the changes present in the gut just proximal to the obstruction, this would seem to be a risky procedure without any special advantage.

At the time of primary operation, there are no positive criteria by which to judge the possibility of the development of a late intestinal stenosis. The intestine, both in our own and the other reported cases was apparently considered viable as judged by the ordinary symptoms of return of color, vascular pulsation, and the reappearance of peristalsis. With an intact and glistening serosa, there may already be extensive mucosal necrosis.

REPORT OF CASES

CASE I—Mrs B. K., aged sixty, was admitted to the Mount Sinai Hospital in May, 1924, with an irreducible femoral hernia of twelve hours' duration, accompanied by cramp-like abdominal pain and vomiting. Examination disclosed a strangulated femoral hernia turning upward over the lower margin of Poupart's ligament.

Primary Operation—Under local anæsthesia, the femoral hernia was exposed through an inguinal incision. The sac contained brownish fluid with a slightly disagreeable odor (not fecal), and the intestine was bluish-black in color. The constriction was relieved and hot saline solution applied. After fifteen minutes' observation, the bowel apparently recovered completely. Normal color and peristalsis returned. The arterial pulsations were

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normal, there was no evidence of venous thrombosis. The serosal layer of the involved segment retained its normal gloss. The involved intestine was therefore considered viable and replaced in the abdomen.

Two weeks after the operation, the patient began to complain of severe paroxysms of abdominal colic, occasionally accompanied by vomiting. Abdominal distention set in, and in spite of the fact that enemas were always partially effectual, the tympanites became more marked. It was concluded that an incomplete obstruction of the small intestine was present. *Secondary Operation*. The abdomen was opened through a left rectus incision under local anesthesia. After a few adhesions had been divided, it was seen that about two inches of intestine had become converted into a narrow, firm, cord-like, rigid structure. Proximal to this area, the bowel was found greatly dilated, distally, it was collapsed. An entero-anastomosis between the collapsed and dilated gut to either side of the obstruction was performed. The patient made an uneventful recovery.

CASE II—R. G., aged fifty, was admitted to the Mount Sinai Hospital in September, 1926, with a strangulated femoral hernia. The hernia had apparently been irreducible for twenty-four hours. She had come in from out of town and on admission, was in very poor condition. In addition to the local condition, the patient was found to be suffering from chronic nephritis with a systolic blood pressure of 230.

Primary Operation.—Immediate operation was performed and a strangulated partial enterocoele (Richter's hernia) was found. After relief of the constriction, the intestine apparently recovered its viability. While it was not considered entirely safe to replace the intestine, a resection was out of the question because of the poor general condition of the patient. A loop of chronic gut was passed through the mesentery of the involved intestine and brought out through the wound. A few days later, a fecal discharge was noted in the wound. This fistula closed spontaneously within a few weeks.

Following her discharge from the hospital, the patient had no symptoms whatsoever, for about a month. Then she began to experience attacks of severe abdominal pain and vomiting, which increased in frequency and intensity. In January, 1927, five months after the original operation, she was admitted to the Bronx Hospital. On admission, definite intestinal cramp and visible peristalsis were noted.

Operation.—The abdomen was opened through a four inch right rectus muscle splitting incision. An area of cicatricial stenosis about $2\frac{1}{2}$ inches in length and $\frac{1}{3}$ the diameter of normal gut was encountered in the lower ileum. It was intimately adherent for its entire length to the tremendously dilated proximal loop. The gut distal to the stenotic area was of normal diameter. A suture anastomosis was performed between the gut proximal and distal to the obstruction. The patient made an uneventful recovery.

CASE III—B. G., aged forty-five, was admitted to the Mount Sinai Hospital in January, 1925. About two and one-half months before admission, the patient had suddenly developed a strangulated inguinal hernia which was operated at another hospital. The findings at this operation are not at our disposal. Following his discharge, he commenced to have cramp-like circum-umbilical pain. The pain was more or less constant, with exacerbations coming on one or two hours after meals. He frequently induced vomiting for relief. Marked constipation had been present. Because of the definite relation of the pain to the intake of food, the patient was referred to the Mount Sinai Hospital, with a diagnosis of possible duodenal ulcer. On admission, the abdomen was distended, and marked borborygmus and visible peristalsis were found. A barium enema showed no abnormality of the colon. Because of the obstructive symptoms, an X-ray with oral ingestion of barium was considered inadvisable. A diagnosis of intestinal obstruction was made.

Operation.—The abdomen was opened through a four inch paramedian incision. A segment of collapsed gut, apparently distal ileum, was encountered and followed to the site of obstruction. A firm, hard, stenotic, greatly narrowed area of intestine $2\frac{1}{2}$ inches long was encountered. The mesentery of this portion of the bowel contained

numerous enlarged, but not especially hard glands Proximal to the involved segment, the gut was greatly dilated, distally it was collapsed An entero-anastomosis between the collapsed and dilated gut was performed, and a gland excised for microscopic examination This was later reported to show chronic inflammatory changes There was no evidence of tuberculosis or neoplasm

A few days after operation, an enterostomy was performed for paralytic ileus, with marked relief of symptoms Four months later the fistula, not having closed spontaneously, its operative closure was undertaken At this time, the previous site of operation was reviewed in order to be certain that there was no obstruction distal to the fistula The involved segment of gut was noted to be in the same condition as at the primary operation The entero-anastomosis between the gut just proximal and just distal to the obstruction was patent The fistula was accordingly excised and the opening in the intestine closed by suture The patient made an uneventful recovery, and has remained well to date

CASE IV—M L, aged forty-five, was admitted to the Mount Sinai Hospital in September, 1926 She had been operated on four years ago at another hospital for a left inguinal hernia, which had apparently recurred shortly afterwards Eight hours before admission it had suddenly become large, painful and irreducible She had vomited three times Examination revealed an irreducible inguinal hernia about the size of a small grapefruit An immediate operation was performed and a bilocular sac containing brownish slightly foul smelling fluid was found Two loops of intestine were found to be incarcerated, one of which showed considerable cyanosis with subserous hemorrhage After a prolonged period of observation and irrigation with warm saline, the loop was considered viable and was replaced The subsequent course was uneventful and the patient was discharged well at the end of two weeks

For four months following the operation the patient was apparently entirely free from symptoms At that time she began to experience occasional attacks of colicky abdominal pain There was no vomiting or constipation At the same time a recurrence of the hernia was noted The symptoms were apparently attributed to the recurrence and another hernioplasty was performed Shortly afterward the patient was seen in the return clinic, and visible peristalsis noted A gastro-intestinal X-ray was taken which showed unmistakable evidence of an incomplete small intestinal obstruction Laparotomy was advised but refused One month later the patient was readmitted to the hospital in a moribund condition with signs of intestinal obstruction and a marked anemia closely resembling pernicious anemia The blood count follows "Hæmoglobin 50 per cent, red blood-cells 2,280,000 Hæmoglobin index 1.1 Numerous macrocytes, a few red blood-cells with stippling, two normoblasts The picture is suggestive of pernicious anemia Her condition was too poor to warrant operation" And the patient ceased soon after admission *Autopsy* showed the following 80 cm above the ileo-cæcal junction the intestine shows a narrowing 8 cm long The area is about $\frac{1}{3}$ the diameter of the normal intestine The ileum proximal is markedly dilated In the region of the stricture the wall of the intestine is markedly thickened and the lumen markedly stenotic The mucosa is cicatricial and there are polypoid excrescences of the preserved mucosa Microscopically the wall of the ileum is seen to be several times normal in thickness The mucosa is denuded of epithelium, the muscularis mucosa is fragmented There is a marked inflammatory infiltration of submucosa and subserosa The liver showed marked fatty degeneration

CASE V—R L, aged sixty-six, was admitted to the Bronx Hospital in May, 1926 Two months before admission, the patient had been operated on at another hospital for a strangulated right femoral hernia of fifteen hours' duration At operation the sac was found to contain bloody fluid The intestine was bluish-black, but the peritoneal lustre was retained After relief of the constriction, the normal color of the intestine returned and the gut was considered viable and replaced

STENOSIS FOLLOWING STRANGULATED HERNIA

Following her discharge from the hospital, she commenced to have violent abdominal pain accompanied by borborygmus. The pain was most marked two to three hours after meals. She became gradually more constipated. On admission there was distention and visible small intestinal peristalsis. Two months after the original operation a laparotomy was undertaken for incomplete intestinal obstruction. The distal 35 cm of ileum was found thickened, stenotic and covered with a fibrinous layer. The mesentery was tremendously thickened and contained numerous large hard glands. Grossly the possibility of neoplasm or tuberculosis could not be ruled out.

The involved segment of gut was resected and an ileocolostomy performed. The patient made an uneventful recovery.

The resected specimen is of great interest. The entire resected portion is greatly thickened, the most marked thickening being in the submucosa. The lumen is markedly stenotic. Five mucosal ulcers in various stages of healing are present. The ulcers vary in size from 1×3 to 1×1 cm in diameter. The intestinal stenosis is most marked in the region of these ulcers.

Microscopically, there is an inflammatory granulation tissue occupying the submucosal layer. The epithelial lining of the gut has an altered epithelium having lost its normal glandular structure. There is no evidence of tuberculosis, syphilis, actinomycosis, or malignancy.

CONCLUSIONS

1 Following the replacement of badly compromised but viable intestine, symptoms of obstruction may appear after a varying free interval.

2 These symptoms are due to a fibrotic intestinal stenosis resulting from mucosal necrosis, thrombosis of small mesenteric and intramural vessels and infection by organisms from the lumen of the bowel. The stricture may be tubular or annular.

3 The obstruction remains incomplete for a long time.

4 Early operative intervention is necessary and should consist of a short circuiting entero-anastomosis or resection.

Thanks are due to Dr. A. A. Berg for permission to report the cases occurring upon his service. The authors are also indebted to Dr. Edwin Beer for allowing them to incorporate a case observed on his service, in the present article.

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SPONTANEOUS RUPTURE OF SPLEEN WITH VENOUS THROMBOSIS *

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IN CONSIDERATION of the condition of rupture of the spleen it is well to bear in mind that there are certain predisposing factors in the normal spleen, which may become exaggerated in various diseases. In a way it may be thought of as a pulpy bag of blood, loosely attached by a vascular pedicle, and were it not for the protection which is afforded in its position, it would, no doubt, be more frequently ruptured. Even in its normal state it is probably two or more times the size which we are accustomed to give it from postmortem experience, and this difference in size during life is wholly a matter of contained blood. During the process of digestion we know that there is a large engorgement of the organ with blood and this as a predisposing factor has been apparently evident in a number of cases of spontaneous rupture.

In various diseases the blood content of the organ is increased, sometimes remarkably, and intrasplenic hemorrhages of minor degree are relatively frequent in such states. Notable among the diseases in which such engorgement of the organ occurs are typhoid fever and malaria, and spontaneous rupture has occurred in a number of cases of both. In 123 cases of spontaneous rupture collected by Berger² ninety-nine were malarial, while of twenty-eight cases of spontaneous rupture during the course of acute illness collected by Wohl³ fourteen had typhoid fever. Even in traumatic rupture, disease has its influence. In spontaneous rupture engorgement with blood is *the* important factor. In traumatic rupture the important disease factor seems to be enlargement and consequent unusual exposure of the organ to injury, although many enlarged spleens are, at the same time, congested.

Whether spontaneous rupture of the organ in a thoroughly normal state actually occurs may be questioned. The large majority of reports concern organs which have been diseased. Susman¹ was able to collect only seven cases, including one of his own, in which rupture of an apparently normal spleen had occurred.

It is difficult to conceive of a normal organ, even of the construction of the spleen, bursting under physiological conditions. Perhaps those seven apparently normal spleens were not normal at the time and site of the hemorrhage. For instance, it would seem easily possible for a hemorrhage to occur as a result of an infarct, the evidence of which might be destroyed in the rupture. Wohl advances the theory that sclerosis and degeneration of the small arterial blood-vessels may be the foundation for hemorrhage in spon-

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taneous rupture, a sort of splenic apoplexy, so to speak, and the frequency of occurrence of arteriolar sclerosis in the spleen, together with the knowledge which we have of various other "apoplexies" make this a suggestion worthy of consideration, although it would seem, as Susman points out, that if this were more than a subsidiary factor splenic rupture should increase in frequency with age

Of the seven cases of spontaneous rupture of normal spleens, only two of the subjects may be considered to have been well at the time, four of the others having shown some alimentary tract disorder, one of these gall-stones, and the fifth, pulmonary tuberculosis. All of which point to the conclusion that a normal spleen does not rupture under normal physiological conditions

CASE REPORT—The case which I have to add to these records came under my observation in July, 1925. J. N. K., white, male, aged twenty-five years, electrician by occupation. Family history negative. July 26 about 1 P. M., just after finishing dinner, he was seized with sudden sharp pain in the left upper quadrant of the abdomen. Almost immediately he vomited. He then took a dose of "salts." About 6 P. M. he took a bottle of citrate of magnesia but his bowels had not moved at the time of his admission to the hospital, about 4 o'clock the next morning. He had not had malaria or typhoid fever. His only previous illness was influenza (four days' duration) in 1920 and he had been perfectly well until the sudden onset of this pain. Upon admission to the hospital his temperature was 90° F., pulse 80 per minute, respiration 26, shallow. Patient well nourished and developed. His abdomen was moderately distended, there was nothing palpated as abnormal, there was no



FIG. 1.—Gross appearance of spleen after removal showing the point of rupture of the capsule, and foci of hemorrhage in the pulp, from the root to the point of rupture of the capsule on the outer or convex surface. Shape of the spleen is altered by fixative solution.

dullness, peristalsis was active over the entire abdomen. Palpation beneath the left costal border revealed tenderness and rigidity. The entire left upper quadrant was rigid. Pressure over any part of the abdomen and over the left kidney region gave sharp pain in left upper quadrant anteriorly. He had no pain in the left shoulder, such as is recorded in other cases, and his physical examination was otherwise negative. His urine showed a trace of albumin, plus two indican, and an occasional pus cell. Hemoglobin 85 per cent (Dare). Leukocytes per c mm 13,040. Polymorphonuclear neutrophils 85. On opening his abdomen it was found to contain about 750 c c of free blood, including many clots. This was found to be coming from a ragged rent in the outer surface of the spleen. The spleen was removed, blood sponged out of the belly, and the patient was given 750 c c of normal saline solution intravenously during the operation. His blood picture continued practically the same, with about 3,000,000 erythrocytes, for the next two days. There then was a steady improvement with gradual return of the red blood corpuscles and hemoglobin to normal and a reduction of the leukocytosis to about 10,000 during the next twelve days. His recovery was uneventful, wound healing by primary union and he left the hospital on the fourteenth day after operation. He resumed his occupation at the end of a month and has remained well since that time. His present physical condition (December 3, 1927)—height 5 feet 8 inches, weight 153¾ pounds, general physical examination negative. Blood examination. Hemoglobin 86 per cent (Dare), erythrocytes 3,980,000, leukocytes 11,200, small and large lymphocytes 30, large mononuclears and transitionals 4, polymorphonuclear neutrophils 64, eosinophiles 2, basophiles 0, other varieties 0. Plate-

let count 280,000 Coagulation time 5 minutes, blood clotting time $2\frac{1}{2}$ minutes Fragility test normal Urine normal Blood pressure (mercury) systolic 130, diastolic 70

The spleen which was removed was of the normal average size and appearance, except for the rent in the capsule (Fig 1) This point of rupture was about the middle of the convex surface and within it the blood was clotting The hemorrhage extended in irregular fashion on through the middle of the organ toward the root The removed spleen was examined by Dr Kenneth M Lynch, and histologically was of normal appearance in so far as the pulp was concerned The capillaries of the Malpighian body appear



FIG 2—Vein of spleen, with surrounding pulp in spontaneous rupture of organ ($\times 100$) Clotting of blood within the veins Seems to be a thrombosis by the irregular distribution of elements of blood but there is no change in the wall and it may have followed the rupture

somewhat thickened and hyalinized Toward the root of the organ the veins contained the elements of the blood in such arrangement as to signify a new thrombus, that is, there was a precipitation of the fibrin, and the red blood corpuscles and leukocytes were in irregularly disposed masses instead of being uniformly mixed This clot was apparently attached to the lining of the vein (Fig 2) There is no evident reason for thrombosis, there was no change in the walls of the veins, there was no apparent infarction, and the thrombosis, if it really was a thrombosis which antedated the hemorrhage, could not have existed for any length of time prior to the operation

It remains a question whether this venous thrombosis was the cause of the hemorrhage into the spleen and the subsequent rupture of the capsule, or whether it was merely the subsequent thrombosis occurring in the bleeding vascular tree

Clinical Features Except for the history of traumatism there seems to be little or no difference in the clinical picture presented by traumatic and spontaneous rupture of the spleen The notable tendency of the spontaneous

SPONTANEOUS RUPTURE OF SPLEEN

occurrence to be related to the engorgement of the organ during digestion seems to be the only feature belonging mainly or exclusively to the latter. Vomiting may or may not happen in either. It is used as a differentiating point by some and is considered late by others. It seems to have been a prominent symptom in the cases of spontaneous rupture of seemingly normal spleen. Paresis and distention of the intestine has been prominent in some but not in others. Abdominal rigidity, usually marked in traumatic rupture, may not be so pronounced in the spontaneous variety, although it may be. It was extreme in my case. Syncope and shock, commonly pronounced in the traumatic, depend in their prominence upon the severity of the hemorrhage in the spontaneous, as does also the evidence of fluid in the abdomen. Pain in the left shoulder, apparently referred from the subphrenic irritation of the blood below the diaphragm and around the spleen through the cervical cord and to the third and fourth cervical nerve, has been an outstanding symptom in some cases of both kinds, and absent in others.

Traumatic rupture is, to my mind, more readily diagnosed because it is more easily anticipated. Spontaneous rupture occurs out of the blue sky, so to speak, and while it may be diagnosed with considerable certainty in a case presenting a characteristic picture, as long as the condition presented is recognized as an acute abdominal crisis demanding immediate operation it makes no difference how positive the diagnosis may be. It merely needs to be borne in mind as one of the things which may be encountered, in order that the splenic area may be accessible to the operator.

As to the choice of the repair of the rupture, or removal of the organ, I take it that the latter is recognized as a safer procedure. Of course where it appears that the rent in the capsule may be easily closed and without danger of subsequent rupture one might suture or tampon the organ but it would be difficult to evaluate the probability of further rupture. Undoubtedly in some cases of both kinds of rupture the bursting of the capsule and the intra-abdominal hemorrhage has followed (in some instances at a considerable interval of time) the primary rupture or hemorrhage into the pulp of the organ. With this in mind and a knowledge of the high mortality of the unoperated or postponed, there seems to be little choice in the matter. Whatever the work of the spleen may be, we know that its presence is not necessary to comfortable life and in an emergency of this degree there should be no hesitation on the ground of saving it.

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ANALYSIS OF ONE HUNDRED AND SEVENTY-SIX CASES OF CARCINOMA OF THE STOMACH SUBMITTED TO AUTOPSY

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IN THE files of the Department of Pathology at the University of Minnesota, for the past twenty years, there are reports of 7,800 necropsies with 570 cases of carcinoma, and 176, 2 per cent of the total, or 30 per cent of the carcinomas show a primary location in the stomach. This necropsy series includes the examinations made by members and associate members of the pathological staff at various places in the Twin Cities, the Miller, Ancker, and Gillette Hospitals in St Paul, and in Minneapolis, the University, and the Minneapolis General Hospitals together with coroner's cases and necropsies performed for practicing physicians. The series then, while not a particularly large one, represents a wide range of incidence and provides interesting material for study.

Sex —As shown in Table I, the greater number, 143 or 81 per cent,

TABLE I

Sex

Males	143	81%
Females	33	19%

occurred in males with thirty-three or 19 per cent in females. This does not, of course, represent actual incidence, for in the University files more necropsies (two and five-tenths to one) are performed upon males. But even after correction is made, it is still apparent that the disease occurs more commonly in males. No definite reason for this is offered. Rough diet and irritating food might be considered as an etiological factor in some men, but with these city dwellers, there can be little difference in the diet of the men and the women.

Age —The age incidence, in Table II, is found to vary widely from thirty-

TABLE II

Age

Noted in 171

30-39 years	12	7%
40-49 years	33	19%
50-59 years	50	29%
60-69 years	59	35%
70-79 years	14	8%
80-89 years	3	1.7%

Youngest 32 years

Oldest 82 years

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two to eighty-two with an average of fifty-nine years. The highest, 35 per cent, occurs in the sixth decade, the fifth decade plays a close second with 29 per cent; then comes the fourth decade with 19 per cent, while a definite number (7 per cent) of the cases occur in the thirties, one at thirty-two. The seventh decade shows about the same number as the third, 8 per cent as compared to 7 per cent while the fewest (1.7 per cent) occur in the eighties. Here again true incidence is not shown since few necropsies are performed upon persons over eighty years of age. A curve showing the age incidence of all the autopsies in the pathological records compared to autopsies on cases

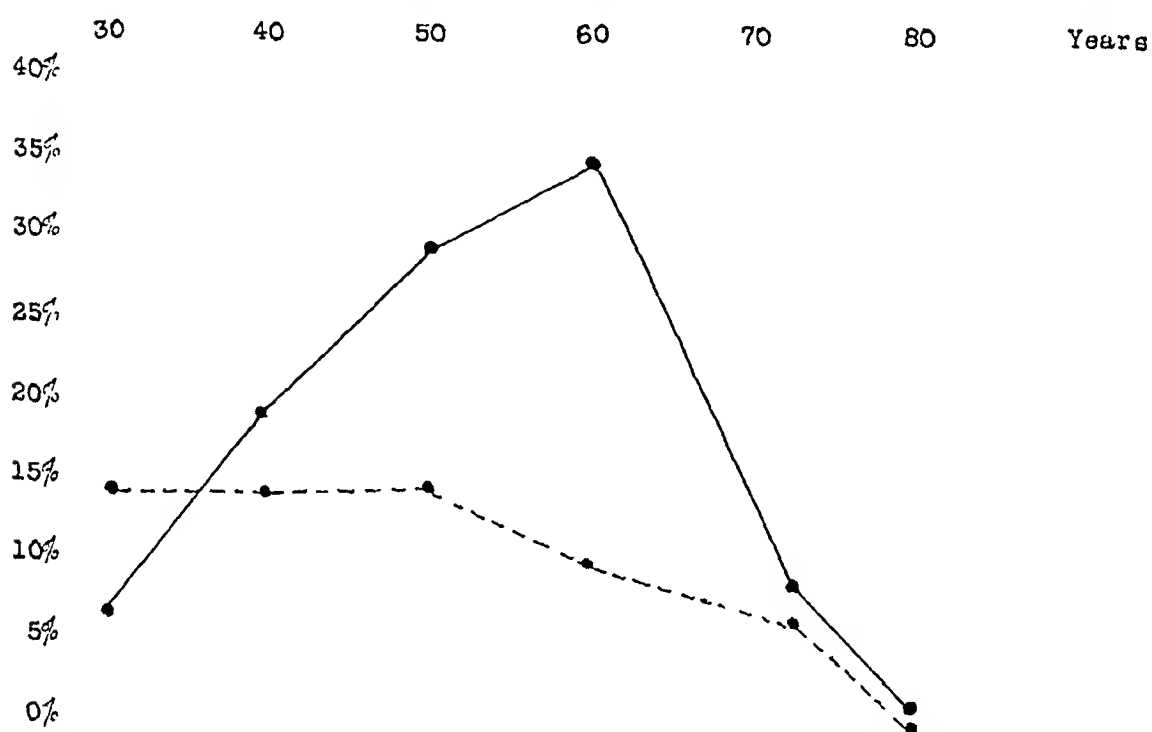


CHART 1—Age incidence of carcinoma of the stomach, as compared with age incidence of total autopsies series ——— Age incidence of carcinoma of stomach ----- Age incidence in total autopsies series

of carcinoma of the stomach is shown in Chart 1. It will be seen that the highest point of autopsy incidence remains fairly constant at about 15 per cent until fifty years from where it drops down to less than 1 per cent at eighty. On the other hand, the age incidence of autopsies of carcinoma of the stomach rises steeply from 11 per cent at thirty years to 35 per cent at sixty years, then at seventy years it drops down to the level of the others. Therefore, we see that the age incidence of cases of autopsies upon gastric carcinoma is much higher than that of the entire series. It becomes apparent that in this study carcinoma of the stomach is a disease of middle life usually occurring after fifty, but sometimes appearing before fifty with occasional cases before forty years of age.

Location—The location of the tumor mass in the stomach wall was described in detail in 175 cases and in Table III there is an attempt at classification which was very difficult of accomplishment because of the few anatomical landmarks in the stomach. The favorite location was the pylorus (42

TABLE III

Location

175 Cases

Pylorus	74	42.2%
Limited to pylorus	41	55%
In wall and pylorus	33	45%
Wall	65	37.0%
Anterior wall	5	7.6%
Posterior wall	16	24.6%
Not mentioned	44	67.7%
Greater curvature	18	27.0%
Lesser curvature	25	38.0%
Not mentioned	22	33.8%
Cardia	19	10.8%
Diffuse	17	9.7%

per cent) and of these slightly more than half (55 per cent) were limited to the pyloric ring while the remainder (45 per cent) extended up on the wall. The wall itself, somewhere between the cardia and the pylorus, was affected in sixty-five cases or 37 per cent of the series. Of these five or 8 per cent were on the anterior wall and sixteen or 24 per cent were on the posterior wall while the majority (forty-four or 67 per cent) did not have the exact position designated. The position on either anterior or posterior walls seemed to receive more consideration since only twenty-two or 33 per cent had no reference to it. The tumor growths were situated on the lesser curvature in twenty-five or 38 per cent , and on the greater curvature in eighteen or 27 per cent. The cardia was the site of the carcinoma in nineteen or 11 per cent of the cases and there was a marked variation in size here also. The majority of the tumors were limited to the zone directly around the cardia, but some of them extended down upon the wall in an irregular manner difficult to classify.

In seventeen or 10 per cent the carcinoma appeared as a diffuse growth throughout the wall, resulting in many of the cases, in the so-called "leather bottle" stomach with stiff hard walls and a lumen much decreased in size. Some of them had ulcers at various points and others had cauliflower-like masses projecting from some point on the inner surface. These cases presented practically the same number and location of metastases as did the others in the series. It is of interest, however, to see that six, or one-third, had an obstruction which seemed to be the fatal factor, so it appears that in diffuse carcinoma of the wall, obstruction has a slightly higher incidence than localized carcinoma of the wall, but not as high as carcinoma of either the cardia or the pylorus.

Ulceration —Ulceration is an expected early complication of carcinoma of the stomach, because the new growth which is more or less bulky, carries comparatively few blood-vessels and is constantly subjected to the digestive action of the gastric juice. But, as is shown in Table IV, ulceration was present in less than half of the carcinomas of this series (43 per cent) according to the

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TABLE IV

Ulceration

Present	76	43 4%
Perforated	39	32 0%
(51% of ulcers)		

gross examination Doubtless microscopic examination would have shown a more frequent loss of surface tissue The ulceration observed varied from an absence of superficial epithelium to complete loss of stomach wall, causing perforation Definite gross perforation was found in thirty-nine which represents 22 per cent of the entire series, and 51 per cent (more than half) of the ulcerated cases This opening in twelve cases, representing 30 per cent of the perforated cases, 16 per cent of the ulcerated cases, and 7 per cent of the total series, was plugged by adjoining structures such as pancreas, liver, lymph-nodes and fibrous adhesions, and consequently there was no resulting peritonitis But in twenty-seven, which represented 70 per cent of the perforated cases, 35 per cent of the ulcerated cases, and 15 per cent of the entire series, there was a direct communication between the lumen of the stomach and the peritoneal cavity resulting in the peritonitis which proved fatal

Obstruction —Obstruction is a common and early complication of gastric carcinoma and usually results in the symptoms which bring the patient to a physician and necessitates operative interference In this series, as shown in Table V, fifty-nine or 34 per cent showed definite obstruction This obstruc-

TABLE V

Obstruction

Obstruction	59	34%
Cardia	19	11%
Pylorus	42	24%

tion was present in the pylorus in forty-two which represents 72 per cent of the cases of obstruction, 56 per cent of the cases of carcinoma of the pylorus, and 24 per cent of the entire series It was present in the cardia in nineteen which represents 32 per cent of the cases with obstruction, 100 per cent of the carcinomas of the cardia and 11 per cent of the entire series In two cases with diffuse carcinoma, it was present in both Therefore, obstruction always occurs with carcinoma of the cardia and usually with carcinoma of the pylorus The degree of obstruction is difficult to determine for there is no accurate method of measuring it and in very few instances was the degree definitely mentioned Furthermore, the anatomic obstruction is not always the same as functional obstruction, and a patent passage through a very stiff walled and rigid pylorus may give much more clinical evidence of obstruction than a large, polypoid, soft mass which appears to entirely fill the lumen of a pylorus with soft walls

Metastases —Since the significance of all carcinomas lies, not only in the primary growth in one organ but also in the secondary growths which may appear

in other parts of the body and interfere with vital processes, the metastatic growths in this series will merit consideration and are shown in Table VI. As would be expected, the majority (78 per cent) showed secondary growths in other parts of the body, but it is of interest to find that nearly a fourth (23

TABLE VI

Metastases

Liver	67	38%
Perigastric nodes	63	36%
Retroperitoneal nodes	51	28%
No metastases	40	23%
Peritoneum	35	20%
Omentum	24	13%
Lungs	21	12%
Mesentery	15	9%
Bronchial nodes	19	9%
Mesenteric	15	9%
Pleura	14	8%
Pancreas	13	7%
Adrenals	8	5%
Intestines	7	4%
Kidney	6	3%
Diaphragm	4	2%
Spleen	4	2%
Gall-bladder	4	2%
Bladder	3	2%
Ribs	3	2%
Uterus	2	1%
Ovaries	2	1%
Brain	2	1%
Vertebræ	1	6%
Prostate	1	6%

per cent) came to autopsy with only the original, primary tumor growth of the stomach. The liver was the favorite site for metastases, being affected in 38 per cent of the cases, while the regional lymph-nodes around the stomach played a close second with 36 per cent, and then came the retroperitoneal lymph-nodes (28 per cent), peritoneum (30 per cent), omentum (13 per cent), and mesentery (9 per cent). Carcinoma was found in the pancreas as well as the stomach, in 7 per cent of the cases, but in an organ situated so near the stomach, it is impossible to distinguish true metastasis from growth continuity when the condition has reached a terminal stage. Metastatic growths were found in the lungs in 12 per cent, the pleura in 8 per cent, and the bronchial lymph-nodes in 9 per cent.

The spleen is usually an infrequent site for secondary carcinomas and this is borne out by this series where they were present in only four cases or 2 per cent of the series. The remainder of the table proves that secondary growths may appear in any part of the body although they are usually present in the liver, lymph-nodes, peritoneum, omentum, lungs or pleura.

The forty cases (23 per cent) which showed no secondary growths pre-

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sent an interesting study in themselves. The question is at once raised whether death occurred from some intercurrent cause or complication before secondary growths had time to develop, or whether the absence of metastases was due to some inherent characteristic in either the individual tumor or in the host. The clinical histories, taken as they were, by various people at various places show no standardization and are of little value in estimating the duration of the disease. Furthermore, the first symptoms do not always give accurate evidence of the appearance of the tumor, for different carcinomas of the stomach present very different clinical pictures because of the wide variety of symptoms which are caused by the location in different parts of the organ. Some of the tumors may grow to a very large size on the wall before causing symptoms, while other very small ones in the pylorus may early cause obstruction which necessitates operative interference or causes death from malnutrition. Therefore, the duration of the tumor growth offers little to explain the absence of metastases. The major complications causing death are shown in Table VII and prove that these patients did not die from intercurrent diseases before secondary growths developed. Almost one-half (45 per cent) died from

TABLE VII

Causes of Death in Cases with no Metastases

40 Cases

Peritonitis	18 or 45	%
Post-operative	9 "	22 %
Perforation	9 "	22 %
Obstruction	5 "	12 %
Operative shock	4 "	10 %
Hemorrhage	3 "	8 %
Severe anemia	2 "	5 %
Endocarditis	2 "	5 %
Meningitis (Pneumococcic)	1 "	2 5%
Suicide	1 "	2 5%
Encephalomalacia	1 "	2 5%
Broncho-pneumonia	1 "	2 5%
Pulmonary abscess	1 "	2 5%
No cause known	1 "	2 5%

peritonitis and in half of these or nearly a fourth (22 per cent) the peritonitis was the result of perforation by ulceration of the tumor indicating that it must have been present for a sufficient length of time to have extended entirely through the stomach wall. Obstruction, hemorrhage and severe anemia were the cause of the death of another fourth of the series and all of these indicate a development of fairly long standing. Eight more died from operative shock and one is justified in thinking that operation would not have been undertaken unless the tumor was causing definite symptoms. Only eight or 20 per cent died from causes which might have been considered as intercurrent or having no relation to the tumor in the stomach. A comparison of Table VII with

Table VIII, in which are shown the diseases or fatal complications causing death in the entire series, shows that they are not very different, and there is no evidence of the cases without metastases dying before secondary growths could develop. Therefore, it seems that the failure to produce metastases must be an inherent characteristic of either the host or of the tumor itself.

TABLE VIII
Causes of Death
176 Cases

Peritonitis	45	26 %
Post-operative	18	10 %
Perforative	27	15 %
Obstruction	34	19 %
Broncho-pneumonia	13	7 %
Gastric hemorrhage	12	7 %
Operative shock	10	6 %
Severe anemia	9	5 %
Obstructive jaundice	9	5 %
Pulmonary tuberculosis	3	2 %
Myocardial failure	3	2 %
Coronary sclerosis	3	2 %
Intestinal obstruction	2	1 %
Abscess of liver	2	1 %
Meningitis	1	5 %
Pulmonary abscess	1	5 %
Lobar pneumonia	1	5 %
Acute cystitis	1	5 %
Bacterial endocarditis	1	5 %
Retrocæcal abscess	1	5 %
Septicæmia	1	5 %
Suicide	1	5 %
Addison's disease	1	5 %
Encephalomalacia	1	5 %
Thrombosis of inferior vena cava	1	5 %
Metastatic brain tumor	1	5 %
Carcinoma alone	19	11 %

Fatal Complications—It is of interest to know just why each one of these patients with carcinoma of the stomach died. Does the mere presence of the tumor in the stomach cause emaciation and death from the so-called "cancer cachexia", does the new growth interfere with the digestive process and cause death from malnutrition, do the secondary tumors in other parts of the body interfere with vital processes and cause death in that way, or does some inter-current disease attack the person already debilitated by the growth of the carcinoma, and cause death by means which would not have proved fatal in normal persons? The major fatal complications of the cases in this series are shown in Table VIII. Of these nineteen or 11 per cent showed no complications and no cause for death other than the presence of the tumor. Many of these had bulky metastases in the liver, but the possibility of death from liver insufficiency could not be proved by the autopsy. The most common fatal

CARCINOMA OF THE STOMACH SUBMITTED TO AUTOPSY

complication was peritonitis which occurred in forty-five cases (26 per cent), and the cause of this was equally divided between operative interference and perforation of the wall by ulceration of the tumor growth. The first impression, then, would be that one stood an equal chance of death from peritonitis in being operated upon or in letting the tumor take its course, but one should remember that the chances of death from perforation are equal to the fatal cases following operation and that many cases are successfully operated upon and do not appear in these statistics. Next to perforation comes obstruction (19 per cent) and this number would doubtless be much greater if many with obstructive symptoms had not been operated upon, and either not appear here at all or else be listed under some fatal post-operative complication such as shock or peritonitis.

The next most common fatal complication is broncho-pneumonia and it is a debatable question whether this is a true intercurrent infection or whether it is a complication of carcinoma, developing in persons already debilitated by the presence of a tumor in the most important digestive organ. It is quite true that primary, fatal broncho-pneumonia is rare in an adult, but it is also true that many of these patients were well nourished and not yet showing any evidence of harm done by the carcinoma. Massive hemorrhage claimed 7 per cent , severe anemia from constant oozing 5 per cent , operative shock, 6 per cent , and obstructive jaundice from encroachment of the new growth upon the bile ducts, 5 per cent. Then follows a long list of diseases which are apparently intercurrent. Upon reviewing this table, summing up the fatal complications, and classifying them according to intercurrent causes of death or as complications due to the presence of the tumor itself, it becomes apparent that the great majority (69 per cent) die from complications directly referable to the growth of the tumor, while 20 per cent die from intercurrent diseases, and complications are entirely absent in 11 per cent. Therefore, in the great majority of the cases (89 per cent) death was due to some definite cause and not to the old "cancer cachexia" which is, in all probability, only the result of the malnutrition caused by the presence of a tumor growth in the digestive tract. Furthermore, in spite of the presence of this new growth in the most important of the digestive organs, all of the patients were not emaciated, in fact 18 per cent were unusually well nourished.

Emaciation —The relationship of emaciation to carcinoma is too old a question to be dismissed without an analysis of this series in regard to that issue. As seen in Table IX emaciation was prominent in the great majority

TABLE IX

Emaciation

Marked	110	62%
Moderate	35	20%
Not present	31	18%

of the cases, 110 or 62 per cent , it was moderate in thirty-five or 20 per cent and entirely absent in thirty-one or 18 per cent. "Cancer cachexia" is sup-

posed to be an accepted thing, but here are thirty-one cases, 18 per cent, almost a fifth, which come to autopsy without any demonstrable emaciation. To be sure some of these had lost some weight, but yet at the autopsy they were still well nourished. For example one large man had lost forty pounds and yet at the time of his death was obese, weighing over 200 pounds. In the face of these observations one cannot say that carcinoma always causes emaciation even though it does affect an important digestive organ. The first supposition would be that death had been caused by some intercurrent disease or complication before the tumor had been present long enough to cause emaciation. However, in Table X are shown the causes of death in the cases without

TABLE X
Causes of Death with No Emaciation

Peritonitis	9 or 29	%
From perforation	5 "	16 %
Post-operative	4 "	13 %
Hemorrhage	5 "	16 %
Obstruction	3 "	9 6%
Anemia	2 "	6 4%
Obstructive jaundice	2 "	6 4%
Broncho-pneumonia	2 "	6 4%
Endocarditis	1 "	3 2%
Suicide	1 "	3 2%
Retrocaecal abscess	1 "	3 2%
Pulmonary tuberculosis	1 "	3 2%
Carcinoma alone	2 "	6 4%

emaciation and they are practically the same as those in the total series. In a comparison of Tables VIII and X it is seen that in both peritonitis leads, and its etiology is equally divided between the causes of perforation and operation. In Table X next comes death from hemorrhage with an incidence of 16 per cent. When 16 per cent die from perforation, causing peritonitis, and 16 per cent from hemorrhage from ulceration of the new growth, it is evident that 32 per cent have died directly from the growth of the tumor even though no emaciation is present. As would be expected, obstruction was a much less prominent complication than in the total series (9 6 per cent) as compared to 19 per cent). It is somewhat surprising to note that there were three cases of obstruction without notable emaciation, but in all of these the obstruction was of comparatively short duration. Even though it was very severe and the patients had lost some weight, they were well nourished at the time of their death. The cases dying without any demonstrable complications were much fewer than in the total series, two or 6 per cent as compared to nineteen or 11 per cent. Another point against the hypothesis of intercurrent death accounting for the lack of emaciation is the presence of metastases in these cases, which were found in twenty-three or 74 per cent while only eight or 26 per cent remained primary in the stomach as shown in Table XI. Furthermore when one compares this table with Table VI showing the metastases in the total series, one finds that they are very similar for in the total series 23

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TABLE XI

Metastases with No Emaciation

Liver	12	38 7%
Perigastric nodes	7	19 3%
Retroperitoneal nodes	8	25 8%
Peritoneum	4	12 8%
Omentum	3	9 6%
Pleura	1	3 2%
Mesentery	1	3 2%
Cerebellum	1	3 2%
Lung	1	3 2%
Ovaries	2	6 4%
Mesenteric nodes	1	3 2%
Mediastinal nodes	1	3 2%

per cent remained primary in the stomach. Therefore, in spite of the well nourished condition of the patients one must conclude that the tumor had been present for some time. A very small number, eight or 5 per cent, died without either emaciation or metastases and the supposition would be that these had died from some intercurrent disease occurring early in the cancer development, but this was not the case. The causes of death in these cases are shown in Table XII and one finds that three died from peritonitis following

TABLE XII

Causes of Death with No Emaciation and No Metastases

Endocarditis	1
Anemia	1
Hemorrhage	2
Peritonitis (Post-operative)	3
Myocardial failure	1

operation, indicating that the tumor had attained size enough to justify operative interference. Two more died with massive hemorrhage and another with severe anemia which presupposes a tumor of some duration. The remaining two died from heart complications, endocarditis and myocarditis respectively, and these (one-fourth) are all that died from intercurrent diseases having no relationship to the growth. From this series, then, since in one-third (35 per cent) emaciation was not marked and in 18 per cent it was not even present, it appears that "cancer cachexia" is not always present and that death, instead of being caused by the "wasting away" usually attributed to cancer cases, is usually due to major complications most frequently dependent upon the presence of the tumor itself and interfering with the vital processes of the body.

SUMMARY

1 This is a study of 176 cases of carcinoma of the stomach taken from the autopsy records of the Department of Pathology at the University of Minnesota.

2 Carcinoma of the stomach occurred more frequently in males than in females.

3 The age incidence varied from thirty-two to eighty-two with an average of fifty-nine years The largest number (35 per cent) occurred in the sixth decade with 29 per cent in the fifth decade

4 The most frequent location was in the pylorus (42 per cent), then the wall (37 per cent), the cardia (11 per cent) and diffuse throughout the wall (10 per cent)

5 Ulceration was present in 43 per cent and of these 51 per cent showed perforation which was plugged in 16 per cent and open, causing a fatal peritonitis, in 35 per cent

6 Obstruction was definite in 34 per cent of which 72 per cent were at the pylorus and 28 per cent at the cardia

7 Metastases occurred in 77 per cent and were absent in 23 per cent The most frequent site was the liver, then regional lymph-nodes, peritoneum, omentum, lungs, mesentery, and bronchial lymph-nodes

8 The most frequent fatal complication was peritonitis, the etiology of which was evenly divided between perforation and operation In 11 per cent there was nothing but the presence of the tumor to account for death

9 Emaciation was entirely absent in 18 per cent , moderate in 20 per cent and prominent in 62 per cent

AN EXPERIMENTAL STUDY OF ARTERIAL COLLATERAL CIRCULATION

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IN RECENT years the knowledge of the surgery of the large vessels has been greatly increased by the contributions of Halsted, Matas, Carrel, Jaeger, and others. The treatment of vascular diseases has been improved. There is an increasing tendency on the part of the surgeon, to attack the diseased vascular system in all locations. In view of this trend of events, it becomes necessary to enlarge our knowledge of the behavior of the great vessels following manipulations. Much attention has been given the collateral channels developed after ligation of arteries. This is as it should be, for blood must have pathways through which to circulate. The technic of arterial suture has been perfected and the effect of a ligature upon the arterial wall has been studied. Finally, it has long been known that arterial ligation results in atrophy of the parent trunk from the first proximal to the first distal branch. Beyond these observations, little has been done to demonstrate the reaction of the vessels to surgical procedures. It was considered that, in view of the increasing importance of this realm of surgery, further inquiry should be made into the natural response of the organism to alterations in the circulatory bed. It was conceived that this might best be done by a study of the constituents of the vascular tree in an extremity. Consequently, experiments were conducted to observe the rôle played by the main trunk, the lateral branches and the vasa vasorum. The function of each of these channels in the development of a collateral circulation was especially emphasized since, after arterial occlusion, the viability of peripheral parts depends upon the efficiency of the collaterals.

The Main Arterial Trunk—In order to determine the necessity of the main arterial channel, the femoral artery was excised from the inguinal ligament to its termination in the popliteal space.

Through a long incision on the inner surface of the leg the artery was isolated and lifted from its bed. It was divided between ligatures at its point of emergence beneath the inguinal ligament. The large branches were dissected out about one inch lateral to the parent trunk and divided. The femoral artery was dissected out in this manner to the point of its division in the popliteal space. The dissection was continued to include the popliteal artery. The tibial and peroneal arteries were isolated and were then drawn up as far as possible, ligated, and divided. Care was taken to avoid the vein and nerve, and muscles were separated along their fascial planes rather than cut. The wound was closed in layers with silk.

Six dogs were operated upon in this manner. In no instance did gangrene occur. Due, no doubt, to the extensive dissection, the leg was slightly tender for a few days. After this time the animal walked upon the limb with ease and without apparent fatigue.

If, in two weeks, the vascular system is visualized by a roentgenogram after injection with Hill's opaque mass,³ a marked dissimilarity between the

normal and operated extremity is seen. This is shown by Figure 1. It will be observed that in the limb deprived of the femoral artery and its terminal branches, there is an amazing increase in the vascular network. The richness of this circulatory bed is the manifestation of the compensatory act. The small vessels have taken over the function of the parent trunk. That they do this adequately is testified by the absence of gangrene or functional disability. Sections of the semimembranosus muscle were taken from the two limbs and stained with Weigert's elastic tissue stain and with hæmatoxylin and eosin. From a study of these specimens



FIG 1.—The dilated anastomotic vessels observed two weeks after excision of the femoral artery and its terminal branches (Side opposite marker)

it was determined that the increased vascularity of the operated extremity was due to a dilatation of preexisting vessels. There was no evidence of the formation of new arteries. The arteries on the operated side were much larger than those in a comparable location in the normal limb.

Thus, the main vascular trunk in this location is not essential for viability and function of the extremity. In the absence of the parent artery, the small, preexisting branches dilate to form a rich vascular plexus on the affected side.

In the dog, blood is supplied to these small arteries from the profunda femoris, the hypogastric, especially the parietal branch, the external circumflex femoris and the anterior femoris arteries.

The Lateral Branches—It has been known since the time of Gooch¹ that after occlusion of an artery it atrophies from its first proximal to its first

distal branch This has been substantiated by Jones,¹ Stilling,¹⁰ Raab,⁸ Warren,¹¹ Halsted,² and Reichert.⁹ The importance of the lateral branches in maintaining the viability of the parent trunk is obvious. It was decided to determine the behavior of the main artery and its branches if segments were ligated without any branch and also with one, two, three or four branches. In this way information could be obtained on the importance of the lateral branches as collateral channels after ligation of the main artery.

Twelve dogs were operated upon. The femoral artery of one or both sides was exposed, and beginning below the profunda branch, ligatures were placed at intervals to the point of division of the channel. These ligatures were so placed as to include segments without lateral branches as well as isolated portions having one, two three or four branches leading from them. Silk was used throughout. In many of the animals silver clips were placed at the site of the ligature for visualization with the X-ray. Healing was uneventful and within a few days the animal used the limb freely. There was no instance of gangrene.

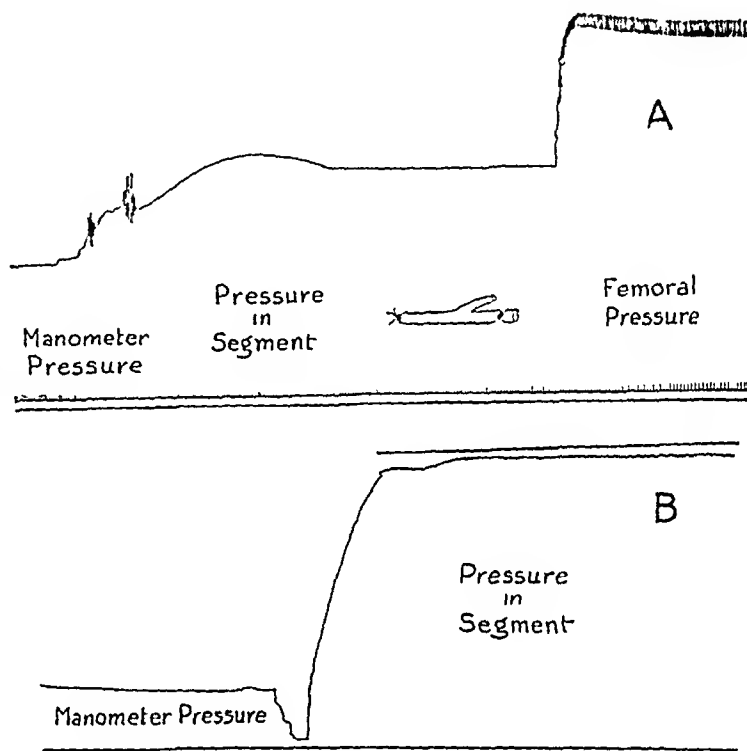


FIG 2—The blood pressure in an isolated segment of artery having one branch. A Forty eight hours and B ten days after operation.

The blood pressure in a segment having one or more lateral branches rises rapidly. If the immediate effect is obtained, in an animal whose femoral pressure, measured in mm Hg, is 176 it is found to fall to 32 and to return to 92 in ten minutes. At the end of forty-eight hours the pressure is 104 and in ten days has reached 124. This is shown in Figure 2. In the arterial segments without branches there is never pressure.

The end result of such isolated portions is important. In Figure 3 is shown all of the different preparations in an animal fourteen weeks after operation. It is noted that both segments isolated without branches have atrophied. The portion of femoral artery having one branch between ligatures has been greatly reduced in size, but the lumen near the branch is patent for it has partially filled with the injection fluid. An isolated segment having two branches is, perhaps, the most interesting. Here it is found that the main artery has atrophied between the ligatures and the branches while that part between the branches has become smaller. It appears that the arterial trunk is

becoming an integral part of a smaller artery, which now consists of a branch in which the current must be reversed, the main artery between the branches, and a branch in which the direction of flow is unchanged. A segment of artery which has three or more branches leading from it atrophies between the ligature and the first branch and then resumes its normal calibre.

It is found, therefore, that one or two lateral branches prevent total atrophy of the parent trunk after its double ligation and with more than two branches the main artery is unchanged.

Vasa Vasorum—The part played by the vasa vasorum as collateral channels has long been a debated question. The drawings of Porta⁷ portray, after ligation of the aorta, small anastomotic vessels which are not named but which appear to be vasa vasorum. They were so considered until Reichert's⁸ careful work showed them to be new formed vessels. This does not prove, however, that these small vessels may not act as collateral channels. Lewis and Reichert⁶ have demonstrated that throm-

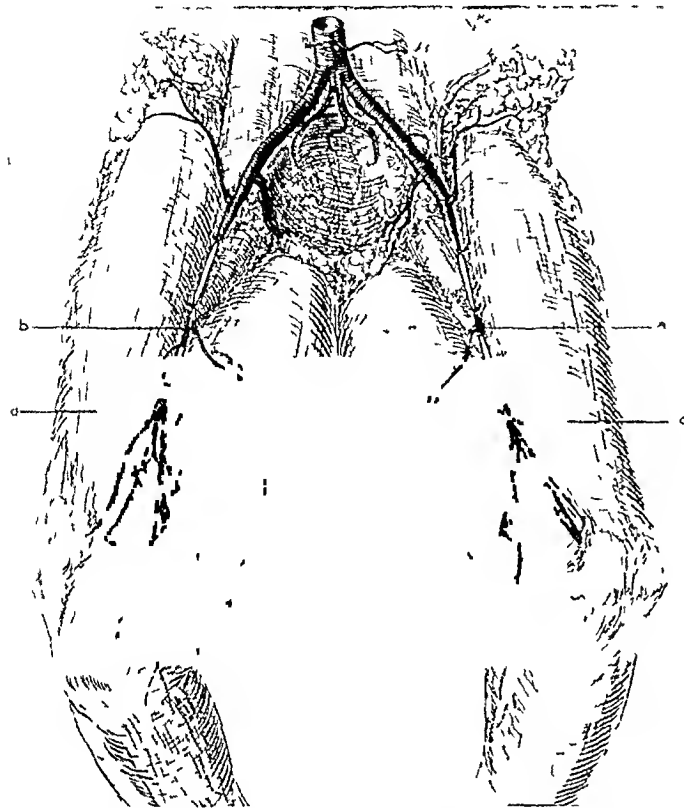


FIG 3—The result of isolated segments fourteen weeks after operation. The first segments have no branch. a Shows a one branch segment with the branch and lumen filled. b Illustrates a two branch segment. c and d Are three and four branch segments respectively.

bo-angitis obliterans differs from arteriosclerosis in having an extensive collateral circulation and Lewis believes the presence of the vasa vasorum is partially responsible for the result. It would be desirable, therefore, to settle the long debated question of the possibility of the vasa vasorum acting as collateral channels. The simplest method would be to show that these nutrient vessels passed around an obstructing ligature placed on the parent artery. This has been accomplished.

On undertaking this problem, a survey of the literature revealed that (1) there was no adequate anatomical description of the vasa vasorum (2) there was no method of injecting these vessels. Perhaps the best description is to be found in Kollicker's *Anatomie*.⁵ After some experimentation it was found that, if a 2 per cent aqueous Prussian blue solution was injected into the lumen of a branchless segment of artery, the vasa vasorum would fill. The carotid is the most convenient artery for the purpose. A cannula is placed

in the lumen at a point low in the neck, the blood is gently expressed from the artery, and with minimum dissection a ligature is placed just proximal to the next branch. This gives a branchless segment of approximately three inches. Injection is carried out at 180 mm Hg for five minutes or until the vasa vasorum are well filled. The specimen is removed and placed in formalin. The next day the lumen is opened and the excess dye removed. The specimen can then be sectioned, dissected or cleared for study.

Observations were made on the mode of origin, anastomosis and destination of the vasa vasorum which revealed the inadequacy of the previous description. When the work had reached this stage an article by Woodruff¹² appeared on the subject giving data obtained from the aorta of the horse and dog, which adequately supplied the deficient information. Consequently no attempt will be made to duplicate this description, it being sufficient to state that this independent work on the carotid substantiates in every respect the findings of Woodruff on the aorta.

If the vasa vasorum are injected within twenty-four hours, after ligation of the carotid artery they do not cross the ligature. However, they are found to have an amazing anastomosis with the small arteries of the surrounding tissue and by this means the vasa vasorum on the distal side of the ligature fill with the dye. Later, the vasa vasorum destroyed at the time of ligation, regenerate and pass over the ligature. Thus, there are two sets of vessels passing around the obstruction, those which are vasa vasorum proper and those which anastomose with the vasa vasorum and after traveling out into the surrounding tissue return to them. This is shown in Figure 4. That these small vessels actually are collateral channels is shown by the fact that if the lumen is opened distal to the ligature during the process of injection the dye will flow from it.

Thus, it is shown that the vasa vasorum may act as collateral circulatory channels after arterial ligation.

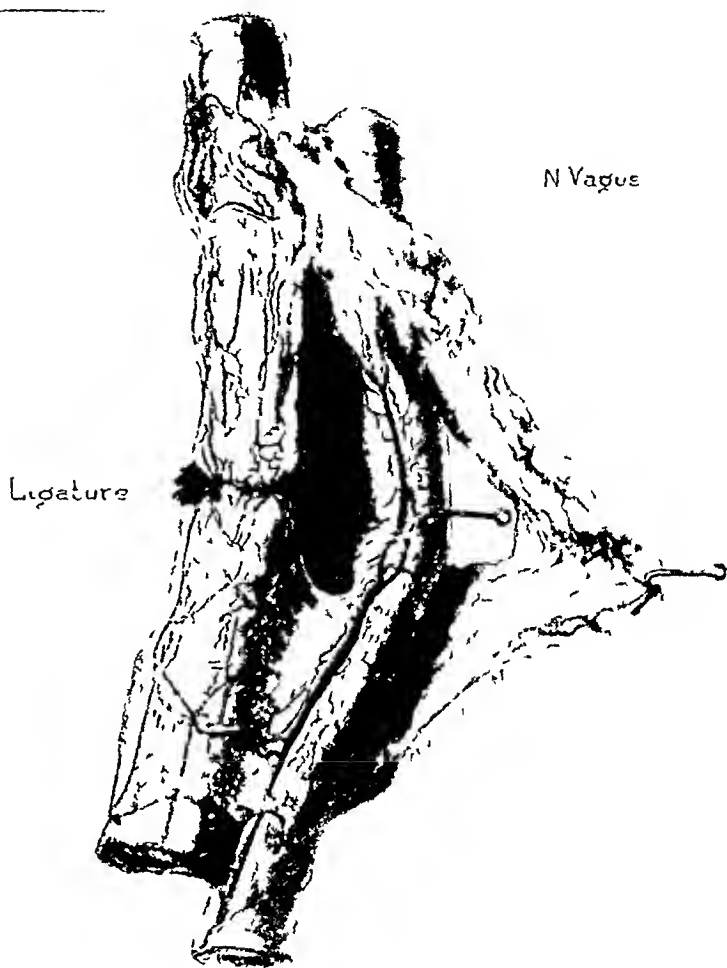


FIG. 4—The anastomosis of the vasa vasorum above and around a ligature on the main artery.

SUMMARY

1 The main artery of an extremity may be completely excised without subsequent gangrene or functional disability

2 The removal of the principal artery is compensated for by the dilatation of the smaller vessels which results in a rich vascular plexus

3 One or two lateral branches seem to prevent total atrophy of a segment of artery isolated between ligatures

4 Three or more branches preserve unchanged an isolated portion of the parent artery

5 The vasa vasorum pass around a ligature obstructing their parent artery and so act as collateral channels

I am indebted to Dr Dean Lewis for many helpful suggestions during this work

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TEMPERATURE EFFECT OF POPLITEAL VEIN LIGATION IN THROMBO-ANGITIS OBLITERANS AND ARTERIOSCLEROSIS

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IN RECENT years it has been well established by both clinical and experimental evidence that ligation of a large artery should be accompanied by ligation of its companion vein, for it has been demonstrated that this procedure results in a diminution in gangrene and an increase in functional ability.^{1, 2, 3, 4, 7, 10, 11, 12} It has further been shown that this results in (a) an increase in residual arterial pressure,^{5, 6, 13} (b) an increase in the venous pressure,¹ (c) an increase in the minute volume flow from the end of the divided artery,⁴ and (d) an increase in the peripheral arterial circulatory bed.⁹ It is probable also that it increases the capillary circulation but direct evidence on this point is lacking. It is easily seen, therefore, why ligation of the companion vein after arterial occlusion diminishes the incidence of gangrene since it so materially improves the mechanics of the circulation.

It was reasoned that, if after arterial ligation, gangrene could be prevented by occlusion of the vein then it might be equally true that impending gangrene from arterial disease could be avoided by vein ligation. It is realized that in the first instance there is a sudden complete occlusion of the artery in one location while in the latter case there is a gradual, more generalized constriction of the lumen but the same mechanical factor of reduced peripheral arterial blood is present in each. Consequently it is reasonable to suppose that since there is improvement in the one instance, there should be some benefit in the other.

The analogy appeared to hold and it was decided to ligate the popliteal vein in cases with circulatory deficiency of the extremity, such as arteriosclerosis and thrombo-angitis obliterans. This has been done in a few instances and it has been found to relieve pain, to increase the temperature of the limb and apparently to increase the peripheral circulation. The number of cases is too small and the time elapsing since operation too short to properly evaluate this procedure. It is not intended at this time to propose it as a method of treatment of vascular disease but it is desired to record the changes in the temperature of the extremity following popliteal vein ligation.

When this procedure was first carried out it was thought that there was no precedent in the matter but it was later found that Oppel¹⁴ had previously done this operation in six cases.

METHOD

Skin or surface temperature was determined by the surface thermometer shown in Fig 1. This instrument is of an aneroid type used years ago and is calibrated in Centigrade and Fahrenheit scales*. It is made to register by placing it firmly against the skin for about three minutes. This instrument, old fashioned as it is, was found to be the most satisfactory means of determining surface temperature.

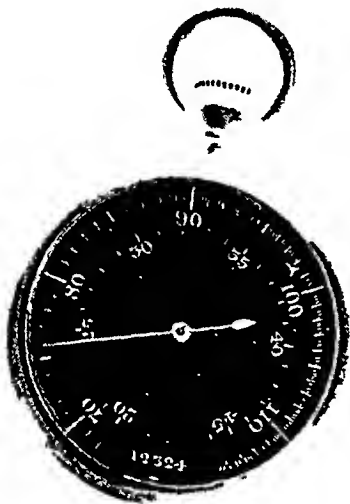


FIG 1—Aneroid type of thermometer with which the surface temperatures were registered

It was desirable, also, to ascertain the temperature of the deeper structures and this was done by the thermo-couple galvanometer shown in Fig 2†. This instrument consists of a "hot" junction of copper and constantan wire fused in the point of a needle with a similar "cold" or constant junction in the thermos bottle. The difference in temperature between these junctions produces a current which is measured by a microammeter and is interpolated into degrees of temperature by calibration of the instrument.

Ordinarily these thermo-couple junctions were inserted into the base of the gastrocnemius muscle for determination of the temperature of the deeper tissues.

In all instances the temperature of the operated extremity was compared with the temperature of the same location on the opposite side. When the temperature of a limb is spoken of as being elevated it is meant in reference to the same location on the opposite member.

CASE REPORTS

CASE I—P. B., No. 8167, male, Jew, forty-one years, admitted June 21, 1927. The patient had been told he had diabetes but no evidence of this disease was found. Five months before admission he developed gangrene of the right foot with spontaneous amputation of the great toe. Four months before admission gangrene of the left foot appeared. There was claudication with exertion before onset and rest pain after the appearance of gangrene.

Physical Examination—General examination essentially negative except for extremities, blood pressure 110/70, white blood-cells 8,300, haemoglobin 85 per cent, Wassermann negative. *Extremities*—There has been a spontaneous amputation of the right great toe and parts of the other toes of the right foot. There is a discharging sinus over

* This thermometer is the property of Dr. W. J. M. Scott and was used by his grandfather in practice.

† This instrument was made by Dr. Stafford Warren. We are indebted to him for its use.

POPLITEAL VEIN LIGATED IN THROMBO-ANGIITIS

the metatarsal phalangeal joint of the left great toe and the skin is dusky. The pulsations of the popliteal, dorsalis pedis and posterior tibial arteries are impalpable on both legs. Urine Sugar negative. Blood sugar 100.2 mg per 100 cc. N P N 26.0 mg per 100 cc. X-ray shows calcification of the vessels of both legs.

Impression Thrombo-angitis obliterans. Amputation advised and refused.
June 28, 1927, ligation left popliteal vein (The popliteal artery was pulsating).



FIG 2—Thermo couple galvanometer, consisting of six hot junctions in the needles connected to a cold junction in the constant temperature "Thermos" bottle. Each thermo couple is controlled by a switch which connects it to the microammeter.

Temperature changes—	Left	Right
Before operation	86° F	
½ hour after operation	88.7	87.5
4 hrs after operation	88.7	87
1 day after operation	90.7	88.2
2 days after operation	91.6	89.6
10 days after operation	88	85.5
24 days after operation	85	83

This difference in temperature was easily made out by a number of observers, subjectively it was also appreciated by the patient.

CASE II—I G, No 9567, male, Jew, fifty years. The patient has had diabetes for thirteen years with loss of thirty-six pounds in weight. Eight months before admission began having cramps in the left leg with exercise. There developed similar symptoms in the right leg four weeks before admission. The condition progressed rapidly especially in the right limb and claudication appeared after walking a few yards and rest pain developed that required morphia for relief.

Physical Examination—The patient is an emaciated, middle-aged man in extreme pain. There is retinal scarring, tortuous, sclerotic, peripheral arteries, an undescended testicle, left, a right indirect inguinal hernia and a moderate amount of benign pros-

MORTON AND PEARSE, JR

tatic hypertrophy *Extremities*—Both legs are pale and cold below the knee with imperceptible pulsation in the arteries There are brown scars over the tibiæ and over both heels The sensation of the legs is diminished, motion is limited and the reflexes are absent The right foot is a reddish-purple in color with frank gangrene of the toes and blebs at the ankle

Course—Amputation advised and accepted September 12, 1927, mid-thigh amputation At operation all the vessels were sclerosed and tissues boggy September 22, 1927, gangrene of stump developed October 18, the right femoral vein ligated Slight œdema of the stump for two weeks, after which the œdema subsided and the wound healed by granulation Discharged December 22, 1927 Electrodes inserted before operation Ligation of right femoral and great saphenous veins (femoral artery pulsating)

At Operation—Deep Temperature

Time	Right	Left
10 32	90 7	93 8
10 33	91 0 —Femoral ligation	94 0
10 37	90 13	94 2
10 39	90 26 —Saphenous ligation	93 8
10 44	90 39	93 8
10 48	90 26	93 8
10 53	90 26	93 8
10 58	90 26	93 8
11 03	90 8	93 4
11 08	91 82	94 8
11 13	93 0	94 8
11 19	93 2	95 0
11 22	93 0	95 0

Temperature Changes

	Right	Left
1 day after operation	91 0	89 0
3 days after operation	91 6	89 3
3 days after operation	101 5	95 7
6 days after operation	90 8	89 8
8 days after operation	90 8	90 0
10 days after operation	91 8	91 0
15 days after operation	91 0	89 6
28 days after operation	90 2	91 0

CASE III—M S, No 9845, female, fifty-four years, admitted September 17, 1927 The patient has had diabetes for fourteen years In November, 1926, she trimmed a callus on the left great toe with a razor and a running sore developed and has persisted September 11, 1927, ulcers developed in the second and third toes of the right foot She has had no claudication and very little pain in the feet

Physical Examination—An obese woman of fifty-four years with hypertrophied tonsils and slight emphysema of the chest *Extremities*—There is redness and swelling of the toes of both feet with œdema on the dorsum of the right foot The dorsalis pedis and posterior tibial arteries are palpable and there is no calcification of the vessels seen in X-rays On the right there is frank gangrene of the second and third toes with infection extending up the flexor tendon sheaths There is an ulcer on the medial surface of the left great toe with a subcutaneous abscess on the plantar surface of the foot

Impression—Diabetes mellitus with infection of the left foot and gangrene of the right second and third toes

POPLITEAL VEIN LIGATION IN THROMBO-ANGIITIS

Amputation advised and refused and patient given palliative treatment The infection of the left foot subsided while the gangrene of the right foot progressed October 14, 1927—Ligation of right popliteal vein, excision wedge of second and third toes right (strong pulsation of popliteal artery)

Course—The wound in the popliteal space healed by first intention and the wound in the foot granulated and healed in three weeks Patient walked on the twenty-ninth day post-operative Discharged November 12, 1927

Temperature Changes

	Right (Popliteal vein ligated)	Left
Before operation	89.0	89.5
½ hour after operation	92.0	89.0
1 day after operation	89.5	87.0
4 days after operation	91.0	90.1
7 days after operation	89.2	88.4
10 days after operation	90.2	90.2
12 days after operation	93.0	93.2
14 days after operation deep temp	93.4	93.8
18 days after operation	89.8	90.0

CASE IV—M. W., No. 11302, admitted November 28, 1927 The duration of diabetes is unknown Fourteen years ago the patient had a chronic infection of the right foot for one year Five years ago she had an ulcer on the right calf that required about ten months to heal Five weeks before admission the patient cut a corn with a razor and an ulcer developed The surrounding tissue, became red and tender and the patient experienced severe pain Frank gangrene developed three weeks before admission

Physical Examination—The patient is an emaciated woman of sixty-two years who is quite senile Right pupil does not react to light and there is a cataract of right lens Teeth extracted Heart enlarged with a systolic blow over the precordium Blood pressure, 130/70 There is sclerosis of all peripheral arteries The liver edge is palpable The reflexes are sluggish Both extremities are pale and cold with impalpable vessels At the base of the fifth right toe is an excoriation 1 cm. in size and at the base of the right great toe and down the medial side of the foot is an area of gangrene covered with a dry black crust Hæmoglobin 88 per cent, white blood-cells 11,680, red blood-cells 5,140,000 Urine pus cells and albumin B. coli in culture Wassermann four plus Blood sugar 160 mg. per 100 c.c. N. P. N. 36.15 mg. per 100 c.c. Blood culture negative X-ray shows calcification of vessels of extremity with periostitis of tibiae

Impression—Syphilis, diabetes, arteriosclerosis, gangrene right foot, cataract right eye

Amputation advised and refused December 13, 1927, ligation of right popliteal vein (very weak pulsation of popliteal artery) *Course* Diabetes controlled with diet (P 52 F 118 C 56 Cal 1494) Operative wound healed per primum Patient would not submit to lumbar puncture, would not cooperate in treatment and left the hospital against advice, December 20, 1927, seven days after operation

Temperature Changes

	Right (Popliteal vein ligated)	Left
Before operation	89.6	90.0
10 10 A. M. 12/13/27—Ligation of right popliteal vein		
10 25	87.0	86.0
10 29	87.2	86.2
10 34	87.6	86.0
10 42	88.2	86.0
10 50	87.8	85.6

Temperature Changes (Continued)

	Right (Popliteal vein ligated)	Left
10 56	87 8	85 6
11 02	86 9	84 8
11 10	87 0	84 8
11 15	86 9	84 2
11 23	86 9	84 2

Skin Temperature

30 min after operation	90 1	90 1
1 hour after operation	90 2	89 2
2 days after operation	91 2	88 0
4 days after operation	92 1	89 4
6 days after operation	91 9	90 1

CASE V[†]—S D, Rochester General Hospital No 43441, male, Jew, thirty-two years of age, admitted January 19, 1928. About one month before admission the patient noticed a redness and swelling of the left great toe with extreme pain in the foot and calf. This was considered an infected ingrown toe nail. He was first seen in the out-patient department of this hospital January 6, where a tentative diagnosis of thrombo-angitis obliterans was made. At this time the left foot was swollen, reddish-blue in color and cold. There has been excruciating rest pain requiring narcotics. A history of claudication could not be elicited. The patient speaks English poorly and his observation is faulty so that the details of the history probably are inaccurate. There has been numbness of the fingers of the right hand for two weeks.

Physical Examination—The patient is a well developed male of thirty-two years in severe pain. The teeth are carious, the spleen is palpable and the blood pressure 148/90.

Extremities—There has been a partial amputation of the right great toe. The right hand is colder than the left. The left foot is swollen, red at the ankle and becomes purplish-red over the distal portion. There is gangrene of the great toe covered with a hard, dry, black crust with demarcation at the metatarsal phalangeal joint. Red blood-cells 4,600,000, white blood-cells 10,900. Urine albumin plus, sugar 0, N P N 35.5, blood sugar 80 mg per 100 c.c. Blood chlorides 520 mg per 100 c.c. Wassermann negative. X-ray shows no evidence of sclerosis of vessels.

Impression—Thrombo-angitis obliterans (Pulsation of popliteal artery not felt). Amputation refused. Ligation of left popliteal vein, February 3, 1928. Pulsation was not made out in the popliteal artery at operation.

Course—Pain was very little relieved, the limb felt cold to the patient and the gangrene steadily progressed. Amputation was indicated and advised but was refused. Discharged February 16, 1928.

Temperature Changes

	Right	Left (Popliteal vein ligated)
Before	90	90
Operation	88 6	87
2 days after operation	92	90
6 days after operation	91 6	91 8
10 days after operation	92	92 6

CASE VI—No 12177, male, fifty-five years, admitted January 1, 1928. Patient has noticed cramps in muscles of legs for four years. In August, 1927, began to have shooting pain in right foot, after walking, accompanied by claudication in leg. These symptoms subsided with rest but appeared more and more frequently. The right foot became red and swollen and four days before admission began to pain even at rest. Patient was told by outside physician that he had diabetes.

[†] This case is reported through the courtesy of Dr Howard Prince.

POPLITEAL VEIN LIGATION IN THROMBO-ANGIITIS

Physical Examination—Shows a large, ruddy, middle-aged man in some discomfort. The vessels of the retina are small and tortuous, the teeth are carious, the tonsils are enlarged, the chest is emphysematous, there is a soft systolic murmur at the apex which is not transmitted, all peripheral arteries are tortuous and the blood pressure is 130/80. The right leg is 2.6° F colder than the left, the popliteal artery is palpable, the posterior tibial is impalpable as is the dorsalis pedis artery. The skin of the right foot is dull in lustre and dusky red in color. There is a black crusted area of gangrene which is 1.7×2 cm in size, at the base of the fourth toe.

Urine—Sugar two plus, hæmoglobin, 106 per cent, red blood-cells, 5,400,000, white blood-cells 8,950, blood sugar 122 mg per 100 c c, N P N 366 mg per 100, Was-

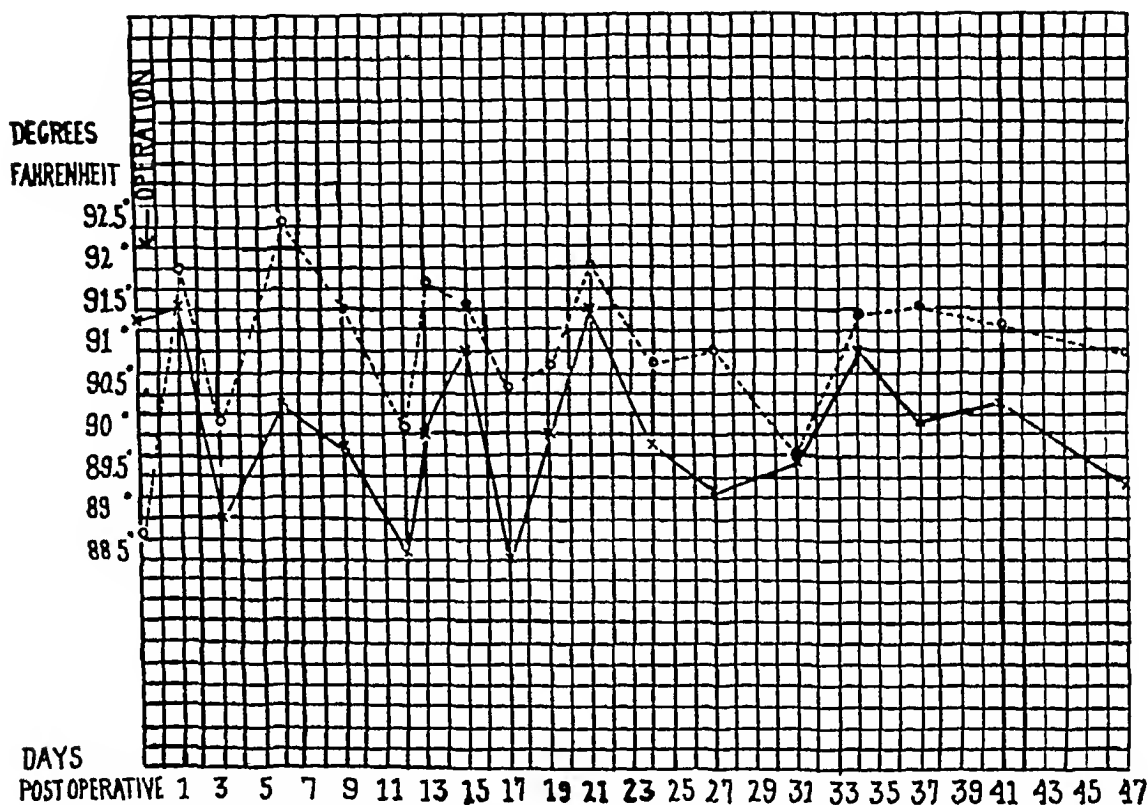


FIG 3.—Graphic record of the surface temperature changes, registered in degrees Fahrenheit, over a period of forty seven days, in Case VI. The dotted line is the operated side, the solid line the control.

sermann negative. X-ray shows calcification of the vessels of the right leg through their extent.

Impression—Diabetes mellitus. Generalized arteriosclerosis. Gangrene right foot.

Operation—January 19, ligation right popliteal vein (strong pulsation of popliteal artery).

Course—Immediately after operation, patient lost all pain and tenderness. There was slight œdema of ankle but the skin became pink and toe nails began to grow. There has never been a return of pain. The gangrene area sloughed down to tendon and began to granulate on February 16, 1928. The temperature change is shown in Fig 3.

CASE V—J B, No 12672, male, sixty-eight years, admitted February 1, 1928. The patient had an infection of the left great toe four years ago and was told he had diabetes. Seven weeks before admission claudication developed in the left leg and two weeks before admission rest pain appeared. Patient has had a chronic cough with dyspnœa and œdema of ankles for fifteen years.

Physical Examination—The general examination reveals pyorrhœa, emphysema, slight cardiac enlargement, generalized arteriosclerosis and a complete right inguinal hernia. Blood pressure 155/90. *Extremities*—The right leg is not remarkable. On the left the distal half of the second toe is gangrenous with specks of gangrene on the tips.

of the third and fourth toes which after three days progressed to gangrene of the distal portion of the toes. The dorsum of the foot is reddish-purple with scales of epidermis lifted from it. The dorsalis pedis and posterior tibial arteries are not palpable. X-ray shows calcification of the vessels. Urine. Albumin two plus, red blood-cells 5010,000, white blood-cells 15,000, hæmoglobin 95 per cent, blood sugar 148 mg per 100 cc, Wassermann negative. February 4, 1928, ligation of left popliteal vein (no pulsation in popliteal artery).

Course—The gangrene, which had been rapidly progressive since admission was checked for a few days, then it continued to extend and the leg was amputated. February 13, 1928.

Temperature Changes

	Left (popliteal vein ligated)	Right
2/1/28 before operation	82.0	83.0
2/4/28 before operation	87.0	90.3
30 min. after operation	87.6	89.6
1 hr. after operation	86.6	87.6
1 day after operation	89.0	91.0
2 days after operation	91.0	90.6
4 days after operation	91.4	91.2
6 days after operation	90.0	91.1

DISCUSSION

Observation of the cases presented has shown that in the presence of arterial disease with circulatory deficiency of an extremity, ligation of the popliteal vein results in an increased temperature of the part. The cause and significance of this phenomena is not clear. It is certain that tissue temperature is intimately connected with the circulation, and it is possible that the increased temperature of the extremity having its deep vein ligated results from a better circulation to the part. But this cannot be accurately determined for there is no absolute criterion of circulatory efficiency in a limb. One may gain an impression by the clinical observation of the relation to pain, the effect on œdema, the change in color, the growth of the nails and the effect on fatigue and this impression may be substantiated by the change in the temperature of the part, the absorption of intradermal saline, the return of circulation after blanching, the oscillometer reading, the capillaries of the nail bed and the oxygen carrying capacity of the returning blood. In the cases studied, it appeared that the change in the temperature of the limb correlated closely with the other signs of functional ability of the circulation. It is to be noted that the finding of an increased temperature of the part following vein ligation is at variance with the experimental results of Brooks,¹ who observed an immediate fall in temperature at the time of occluding the vein in a limb having its main artery obstructed. Perhaps the difference lies in the condition of the arteries for in Brooks' experiments the artery was completely obstructed by ligation while in the cases observed the artery was, usually, only partially occluded by the disease.

It has been shown that the arteries and the superficial veins are equipped with a regulating nervous mechanism, and it may be that manipulation of the popliteal vein results in a derangement of the vasomotor mechanism of the

vessels It is of interest in this regard to note that Leriche⁶ and his pupils have demonstrated an increased temperature of the limb following periarterial sympathectomy

It is possible that occlusion of the deep vein shunts the blood through the superficial vessels and this increased vascularization of the periphery causes an increased skin temperature It has been observed that the superficial veins in these cases become enlarged But the increased temperature of the muscles indicates that the effect is not only on the surface but also in the deeper structures

Finally, the study of subsequent cases may reveal other factors involved which have not been adequately considered

It is believed significant that in Cases V and VII where there was only slight transient elevation of temperature no clinical improvement resulted While on the other hand, in the remaining cases, the more marked and better sustained increase in temperature correlated with the clinical evidence of improved peripheral circulation

SUMMARY

Ligation of the popliteal vein in cases of thrombo-angitis obliterans and arteriosclerotic gangrene results in an elevation of temperature of the extremity

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PRIMARY BILATERAL TUMORS OF THE TESTICLE

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FROM THE CLEVELAND CLINIC

PRIMARY bilateral tumors of the testicle occur so rarely that it seems advisable to report each case that is seen in order that the true incidence may be known. This seems especially important in view of the fact that Vidal¹ formerly stated that tumors of the testicle were never malignant when both organs were involved simultaneously. The findings in the case which is here reported offer proof which directly contradicts this statement.

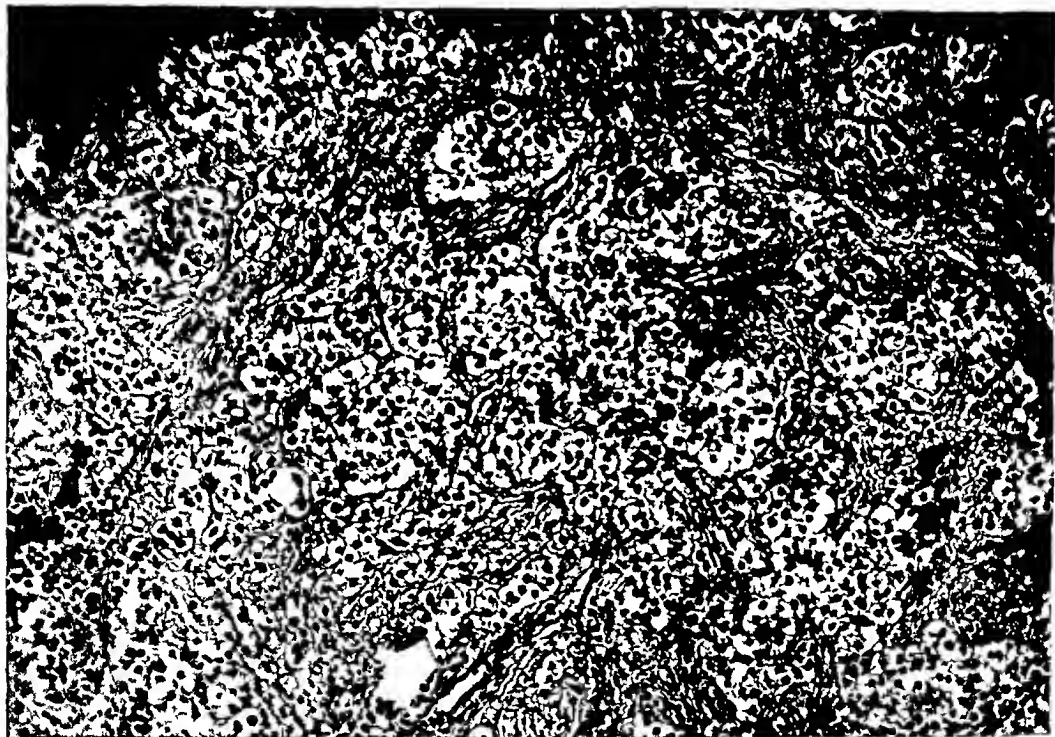


FIG 1A —Embryoma of right testicle. Photomicrograph of section ($\times 160$)

Kocher,² in reviewing the literature in 1887, found that Curling³ had mentioned six cases of bilateral medullary carcinoma of the testicle, and he found the following cases reported as cases of bilateral sarcoma: Wilson, one, Denonvilliers, one (case of Gosselin), Demarquay, one, Adelman, one case in a child (Trelat), Curling, one, Klebs, one, Monod, four, Horner, one, Letulle, one, Kraske, one. To these he added two cases of his own, making a total of fifteen.

The question arises in some of Kocher's cases whether the opposite testicle was not involved secondarily. He states that in the majority of the cases a

PRIMARY BILATERAL TUMORS OF THE TESTICLE

pronounced growth of the second testicle was not markedly noticeable until after the first operation, but usually even at the time of the first operation the second testicle was no longer in a normal condition. The second testicle was operated on at intervals of three, four, six and ten months after the first one had been removed.

Other cases of bilateral tumor of the testicle which have been reported are

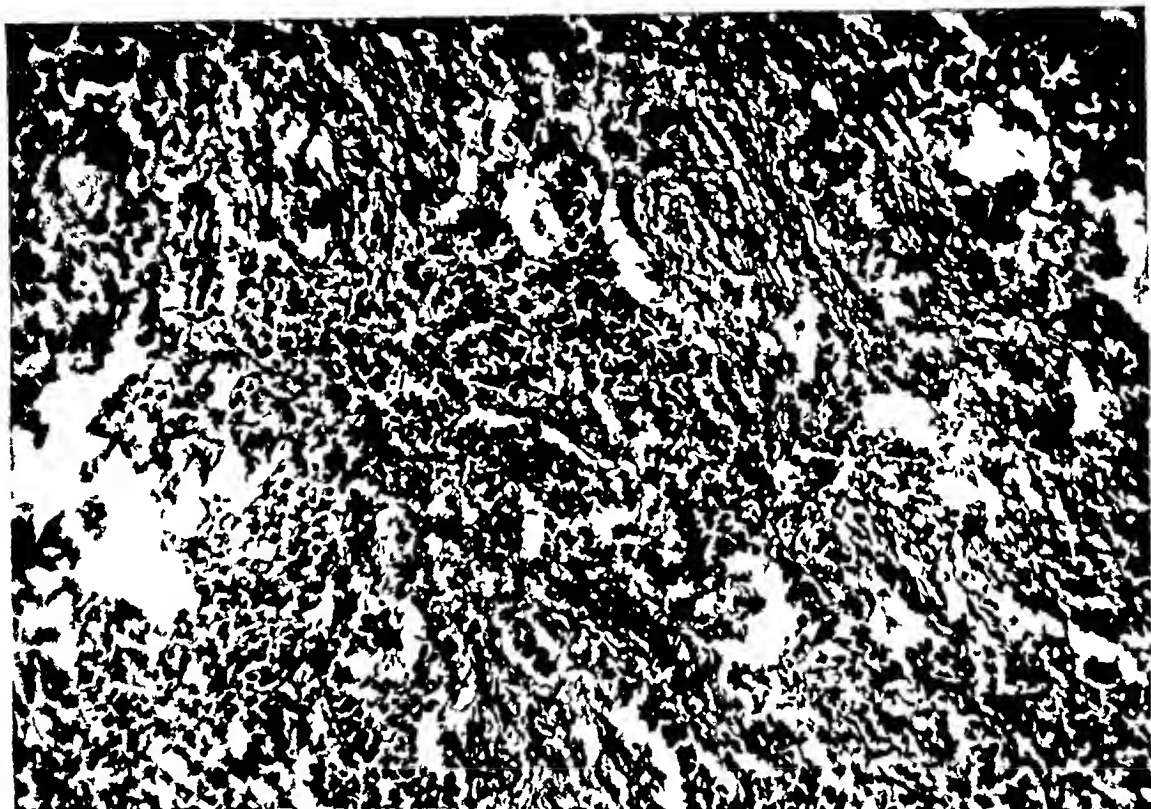


FIG. 2A—Embryoma of left testicle. Photomicrograph of section (X 150).

those of Bidard⁴ (1853), Delaunay⁵ (1860), Sibley and Hulke⁶ (1866), Bowen⁷ (1897), Councilmann and Lovett⁸ (1897), Smith⁹ (1914), Butt and Arkin¹⁰ (1914), Oraison¹¹ (1918), Kaiser¹² (1920), Tanner¹³ (1923).

Klebs,¹⁴ in his "Handbuch der pathologischen Anatomie," states that both testicles are frequently involved, but he is apparently the only author who makes this assertion. In his review of sixty-four cases of cancer of the testis published in 1915, Coley¹⁵ found only one bilateral case, one which had been operated upon by Wyeth¹⁶ in 1905. In this case one testis was retained in the inguinal canal. Bulkley's¹⁷ series of fifty-nine cases of tumor of the testicle retained within the abdominal cavity included only two cases in which there was a bilateral involvement, one the case of Wyeth's which has already been mentioned, the other a case reported by Sabella¹⁸ in 1910.

In recent years but few cases have been reported. Occasionally cases are mentioned in which the opposite testicle has become involved six or seven months after operation or after enlargement of the opposite had been noted, but they cannot be classified as cases of primary bilateral involvement.

Etiology—The etiology, the influence of trauma and of persistent irrita-

tion and the relationship of maldescent of the testes to the formation of tumor have been discussed in a previous paper,¹⁹ in which twenty-three cases of unilateral malignant tumor of the testis were reported. In the majority of these cases enlargement had been discernible before the trauma occurred. In most instances, also, the testicles had descended normally and the enlargement had occurred in later years.

Pathology—Because of confusion existing in the classification of testicu-

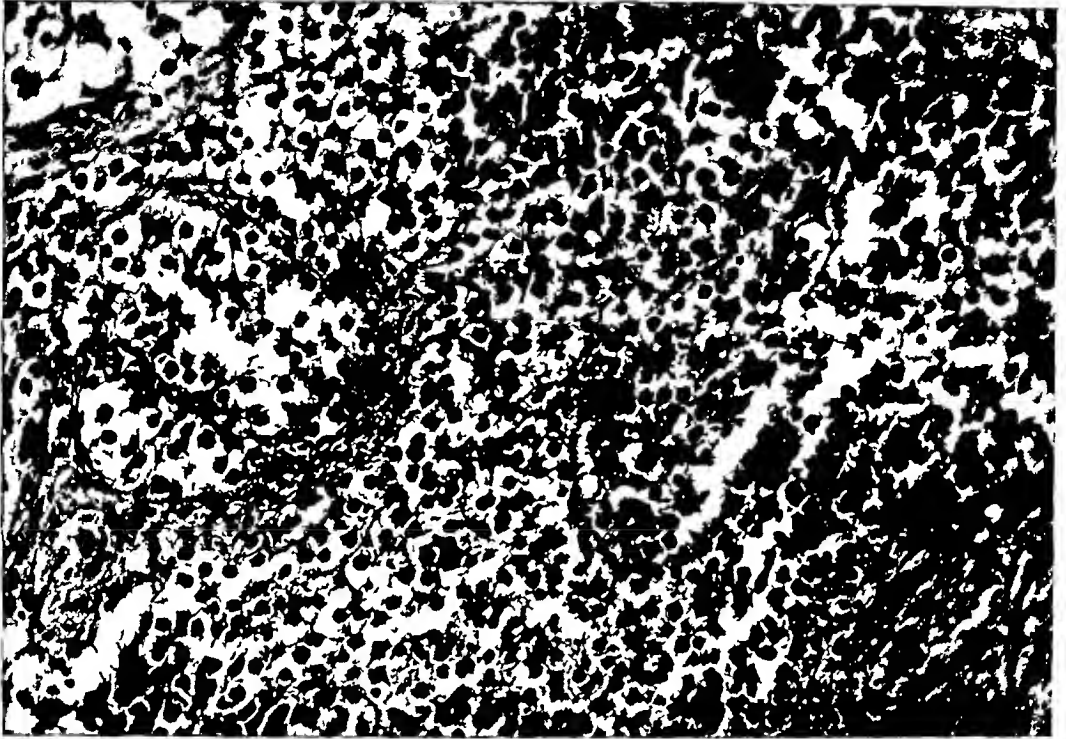


FIG 2A—Embryoma of right testicle. Photomicrograph of section (x 250)

lar tumors, the pathological reports which are given in case reports in the literature often do not agree. Kocher states that variations occur in round-cell sarcomata, the tissues presenting the appearance of small-cell, large-cell and even of giant-cell sarcoma. He states that a number of small round-cell sarcomata fall into the group classified by the French as lymphadenoma and by Kocher himself as lymphoid sarcoma, the microscopic picture revealing the presence of a fibrinous intracellular substance situated between the small round cells. These tumors are very malignant. From the descriptions, however, I believe that many of the tumors fall into the group of embryomata, in which we see large, irregular, deeply staining cells held in a moderately dense and rather loosely arranged fibrous connective tissue.

Kocher also points out the fact that some of the cases which had been reported as cases of sarcoma—notably those of Wilson, Denonvilliers, Demarquay and Adelman might be considered—cases of carcinoma, stating that the same question might be raised in one of his own cases.

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In some of the older cases, as for instance, those of Gosselin²⁰ and Bowen⁷ no pathological report is available

Age Incidence —The majority of the cases of bilateral tumor of the testicle seem to occur in adult life, no case having been found in a child

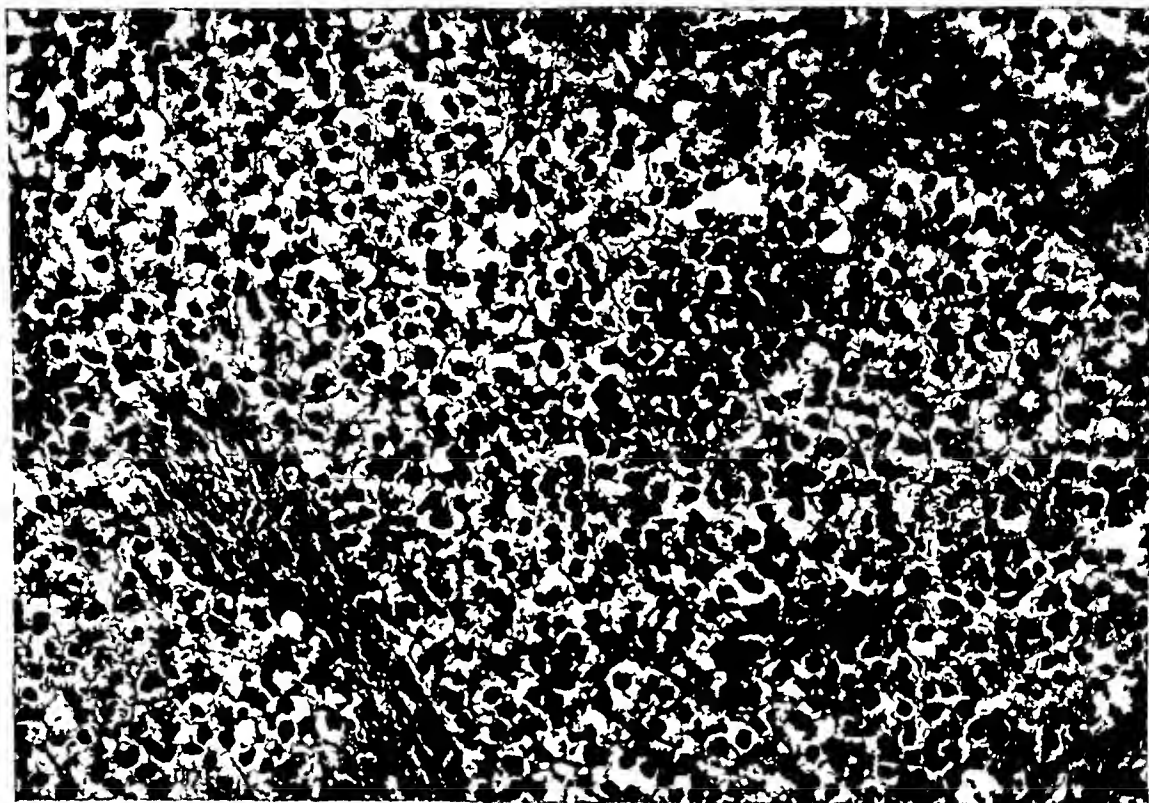


FIG 2B —Embryoma of left testicle Photomicrograph of section ($\times 250$)

The following list gives the ages of the patients in the cases in which this has been noted

Author	No of cases	Age of patient
Kraske	1	42
Kaiser	1	54
Gosselin	1	32
Sibley	1	57
Tanner	1	45
Bidard	1	27
Delaunay	1	30
Oraison	1	54
Wyeth	1	33
Butt and Arkin	1	48
Bunts (case here reported)		54

Diagnosis —The signs and symptoms upon which a diagnosis is based are the same as in the case of unilateral tumors, and here, too, the presence of a coexisting hydrocele may offer difficulty in establishing a definite diagnosis. It may not be suspected that an enlargement of both testicles is present until operation is being performed. In cases in which the enlargement of the opposite testicle ensues months after the primary operation, the diagnosis is less difficult.

Treatment—The treatment is the same as that for unilateral tumors. We recommend orchidectomy and deep radiation of the inguinal and lumbar glands. Coley's serum is also recommended for this condition. However, in all cases of malignant tumor of the testis there is grave danger of early metastasis and the end-results of all forms of treatment have been unsatisfactory.

CASE REPORT—The patient, a man fifty-four years of age, entered the hospital in the service of Dr F. E. Bunts, complaining of swelling of the left testicle. The patient's past history and the family history were unimportant. The swelling had not been associated with pain until one year before, at which time the testicle had been subjected to trauma. The pain recurred in paroxysmal attacks and the swelling progressed steadily. There was no pain in the right testicle.

Physical examination gave essentially negative results except for the findings in the scrotum. The left testicle was enlarged, firm, and in one area it was stony hard. The tumor mass was approximately the size of an orange. A cystic condition was also present in the right scrotum and this was thought to contain a large hydrocele, as light was transmitted through it. No hydrocele was present on the left side.

The left testicle was removed and it was found that the right testicle was also enlarged. As permission had not been granted for the removal of both testicles, the right one was not removed until eight days later.

The patient returned eight months after the operations and stated that shortly after he left the hospital pain developed in the lumbosacral region. It was then a shooting pain which radiated down the legs. Incontinence of feces and of urine had also developed and a paralysis of both legs below the knee. Röntgenograms made at this time showed no evidence of metastasis, however the patient is reported to have died of carcinoma of the transverse colon three months after our examination.

Pathological Report—Left testicle. A testicle and epididymis which together are the size of an orange, showing a finely nodular surface, and on section presenting a rubbery yellowish-white cut surface fairly uniform in appearance.

Microscopic Description—Section through the testicle and epididymis shows a very cellular growth characterized by large, irregular, deeply chromatic cells, with pyknotic and mitotic nuclei held in a moderately dense, rather loosely arranged fibrous stroma of connective tissue, the cells being arranged in some instances in large masses, in other instances in somewhat alveolarlike formations.

Histological Diagnosis—Embryoma of testicle.

The pathological report of the opposite testicle was the same, the pathologist stating that the tumors were identical.

SUMMARY

In reviewing the cases of malignant tumor of the testes reported in the literature, we find that a primarily bilateral involvement has been reported in only a few cases.

A case of primary bilateral embryoma is reported, in order that the incidence of these bilateral tumors may be known and emphasis laid on the importance of a careful examination of the opposite testicle in all cases of unilateral tumor.

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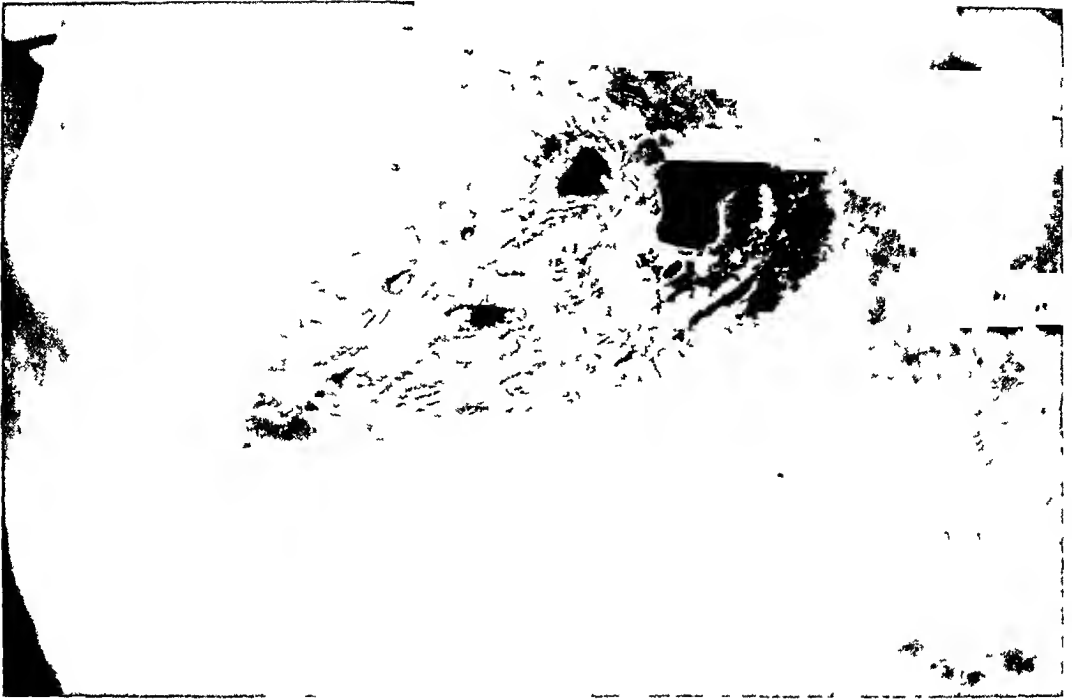


FIG. 4.—Photograph made on October 13, 1927, seven weeks after excision of the ulcer. Note healing is practically complete.



FIG. 3.—Photograph after excision of ulcer and skin grafting. Note growth of epithelium from margin of grafts and ulcer.

PHAGEDÆNIC ULCERATION OF THE SKIN

under treatment. It was extremely sensitive. The man was irritable. He looked haggard, his appetite was poor, and he did not rest well.

It was finally agreed to widely excise this large ulcer, and this was done on July 21, 1927, under gas ether anæsthesia. The line of incision was placed well beyond the lesion, traversing normal skin, and included all the subcutaneous tissue down to the muscles of the back. The base of the ulcer was cauterized.

Following recovery from the immediate shock of the operation and after the immediate pain had subsided, there was a marked change in the man. He lost the evidence of chronic infection. He looked happy, his appetite improved, and he was able to rest very well. Within ten days the base of the ulcer was covered by a good, clean, granulating surface. Skin grafting was done on three occasions—on August 10, August 15, and August 23—and very successfully, each graft taking and growing very rapidly (Fig. 3). During his entire convalescence he was particularly happy and rapidly gained in weight and strength. At the time he left the hospital, on September 9, this large defect was rapidly closing by epithelium which was extending out from the margin of the ulcer and from the skin grafts.

On October 13, 1927, the final photograph (Fig. 4) was taken, which showed the lesion to be practically covered with epithelium.

Paraffin section of the specimen made at the time of the excision of the ulcer and stained by Gram's method showed staphylococci, Gram-positive diplococci and short chains of streptococci.

This case report seems to bear out Brewer's and Meleney's idea that progressive gangrene of the skin is due to the symbiotic action of two or more types of organisms, and in this case, as in the cases which they report, the streptococcus and the staphylococcus seemed to be the inciting organisms.

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FRACTURE AND DISLOCATION OF THE STERNUM *

REPORT OF THREE CASES

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ALL statistics bear out the statement that fracture of the sternum is exceedingly rare. Gurlt,¹ in 1864, cited a series of 22,616 fractures of all types treated at the London Hospital during a period of twenty years. Among them were only twenty-two cases of uncomplicated fracture of the sternum, or 0.098 per cent. Bruns² gives the incidence as seventeen cases in a series of 8,560 fractures (0.2 per cent), Chudowsky,³ as six in 2,366 (0.3 per cent), Plagemann,⁴ five in 1,393 (0.36 per cent). Speed⁵ reported twelve fractures of the sternum in a series of 11,302 fractures treated at the Cook County Hospital during a period of eight years.

The most carefully studied series of cases yet reported was Gurlt's, which was based on a complete survey of the literature up to 1864. Gurlt was able to obtain data on a total of 105 cases. My study of five exceedingly large fracture services revealed sixty-two cases in a total of 46,237 fractures or 0.075 per cent. At Locust Mountain State Hospital during the first year of its opening for patients three cases were detected in a series of 157 fractures, or 1.91 per cent.

Fractures of the sternum are rare because the mobility and elasticity of the thorax protect this bone. Indirect violence rarely produces it, because the ribs are much more likely to break first. Direct injury is the most common cause. However, cases of fracture have been reported not only from indirect violence but also from muscular action.

In ninety-eight cases analyzed by Gurlt with regard to etiology, eight were produced by muscular action, forty-two by falling down from a height, three by powerful bending head foremost, three by violent bending backward, twelve by a blow, thrust, or step on the chest, twenty-two by compression of the chest from being run over, buried, or by the fall of a heavy weight, and eighty by falling with the breast against a solid body.

The usual causes of fracture of the sternum have been given as direct blows on the chest, such as occur in car-bumper accidents, compression of the chest, hyperflexion of the spine associated with fractures of the vertebral column, run-over accidents and falls, and the falling of heavy weights on the

* Thesis submitted to the Faculty of the Graduate School of Medicine of the University of Pennsylvania in partial fulfillment of the requirements for the degree of Master of Medical Science (M.Sc. (Med.)) for graduate work in Surgery.

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chest As an example of fracture by muscular action, there have been cases occurring in the course of labor According to Stimson,⁶ four such cases have been reported Three similar cases were caused by the effort involved in lifting a heavy weight

Some of the unusual cases of fracture of the sternum deserve special mention Malgaigne⁷ related the case of a mountebank who fractured his sternum while leaning backward to lift a weight Gutzeit⁸ cited a case of transverse fracture of the sternum at the junction of the manubrium and gladiolus produced by muscular action The accident occurred while the patient was chinning the bar in the gymnasium and swinging for support Kazda⁹ reported three similar cases produced by injuries incidental to gymnastic exercises

Brunn¹⁰ reported three cases of transverse fracture at the junction of the manubrium and gladiolus produced by indirect violence In each case the cause was the same, namely, the fall of a heavy weight on the back of the neck and the upper portion of the vertebral column, while the body was slightly bent Servier,¹¹ in 1889, was able to collect only twenty cases of indirect or contrecoup fracture of the sternum Tarnowsky,¹² in 1905, added seven new cases collected since 1889, all of them except one being due to muscular action

Michaux¹³ cited a case of fracture of the gladiolus produced by direct violence While leading an unruly ox, the patient was attacked by the animal, whose horn fractured the sternum Knowles¹⁴

reported a case of transverse fracture extending from one-third costal articulation to the other in a Hindoo who was attacked by a wild boar The patient died later of septic pneumonia

MacLaurin¹⁵ reported a case of the exceedingly rare condition of fracture-dislocation of the ensiform appendix The patient was a muscular man and the fracture was produced by the action of his anterior abdominal muscles, while he was trying to save himself from falling forward from a sitting position on a bench On examination, there was a large hollow at the lower end of the sternum which proved to be the result of a forward projection of the ensiform, which lay so that its lower end was tilted forward Gurlt's series contains four cases of this type

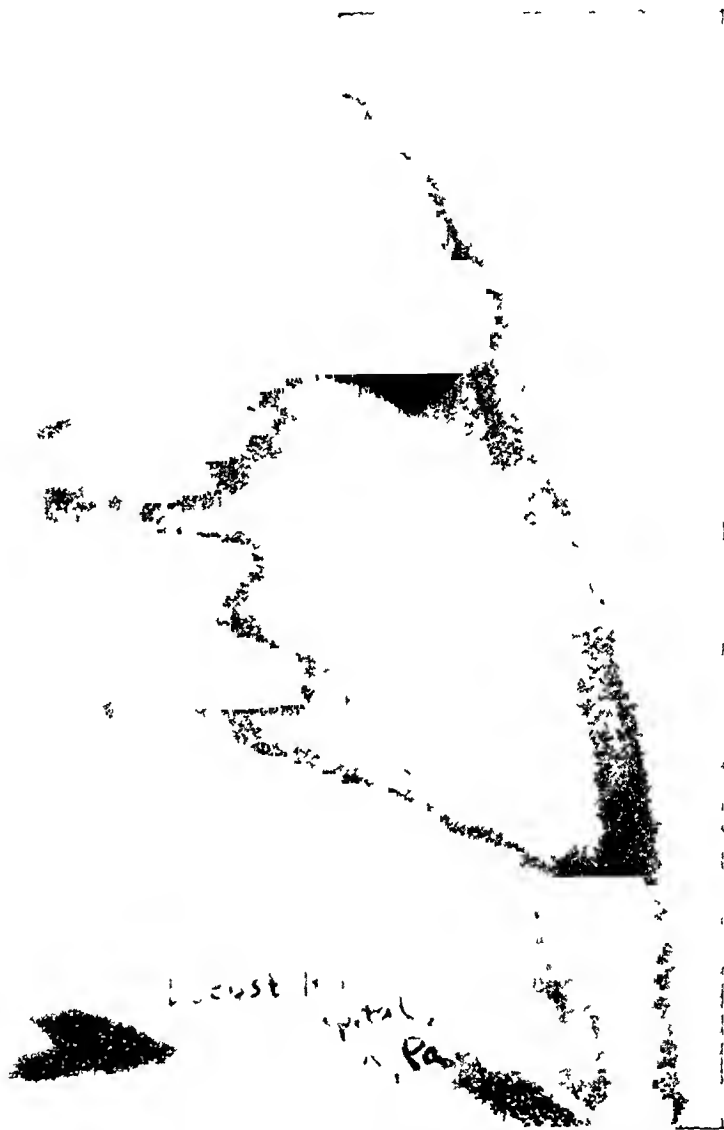


FIG. 1.—(Lateral view of chest) Showing an anterior dislocation of the upper end of the gladiolus at its junction with the manubrium

With rare exceptions fractures of the sternum, exclusive of those that are produced by gunshot or stab wounds, are simple. A notable exception in the way of a compound fracture was the case reported by Du Verney¹⁶ in 1751. The patient was a quarryman who, while lying at work on his side, was caught under a heavy stone five feet long, which compressed his chest

laterally with such force as to separate the middle from the upper portion of the sternum and force it through the skin. The subject died immediately from rupture of the heart and lungs.

The most common type of fracture is a transverse break at the junction of the manubrium with the gladiolus. In the great majority of cases the displacement is such that the lower fragment lies partially in front of the upper one, sometimes overriding it. In children the injury may take the form of a dislocation between the manubrium and the gladiolus.

Of interest with regard to the most common type of fracture of the sternum is specimen No 5156 in the Warren Anatomical Museum, a photographic reproduction of which appears in Wilson and Cochrane on "Fractures and Dislocations."

Fractures of the gladiolus are less common. They are located most frequently between the second and fourth costal cartilages and are usually transverse, there is partial overriding of the lower fragment as in separation of the manubrium from the gladiolus.

Except when other injuries are associated, comminuted fractures of the sternum are rare. Gurlt cited six instances of double fracture and two of triple fracture, all of them associated with other fractures elsewhere.



FIG. 2—(Lateral view) Showing an oblique fracture of the gladiolus just below the middle. The third piece of the sternum, it is noted, is not attached to the second piece but inasmuch as the space is filled with cartilage this is probably a normal condition. Fracture did not show in A P view.

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Though of rare occurrence, several cases of secondary rupture of the internal mammary vessels were reported during the World War Bonnet and Barbier¹⁷ saw two such cases In one, the rupture occurred on the fourth day after injury and was successfully controlled by tamponing under general anaesthesia In the other case, the accident occurred on the fifth day following a fit of coughing Fracture of the sternum may be followed by serious complications in the lungs Wassermann,¹⁸ in 1899, published an exhaustive study showing a high incidence of traumatic pneumonia and active tuberculous infections after such injuries

According to Wilson and Cochrane,¹⁹ the diagnosis is usually quite obvious At the seat of the fracture there are local pain and tenderness and later ecchymosis The deformity, caused by the displacement forward of the lower fragment, may cause a visible and palpable deformity in the form of a ridge near the junction of the second costal cartilages When the lung is injured, dyspnoea and haemoptysis are likely to be present

Roberts and Kelly²⁰ state that the attitude of the patient is often characteristic He takes a sitting position with the shoulders drooped and part of their weight supported by the arms on each side of the bed

DaCosta²¹ attaches importance to the history of the injury in making the diagnosis He describes the posture as one with the head and body bent forward, attempts to straighten up cause considerable pain He believes that crepitus should be elicited by palpation, placing the hand over the injury and asking the patient to take a quick breath

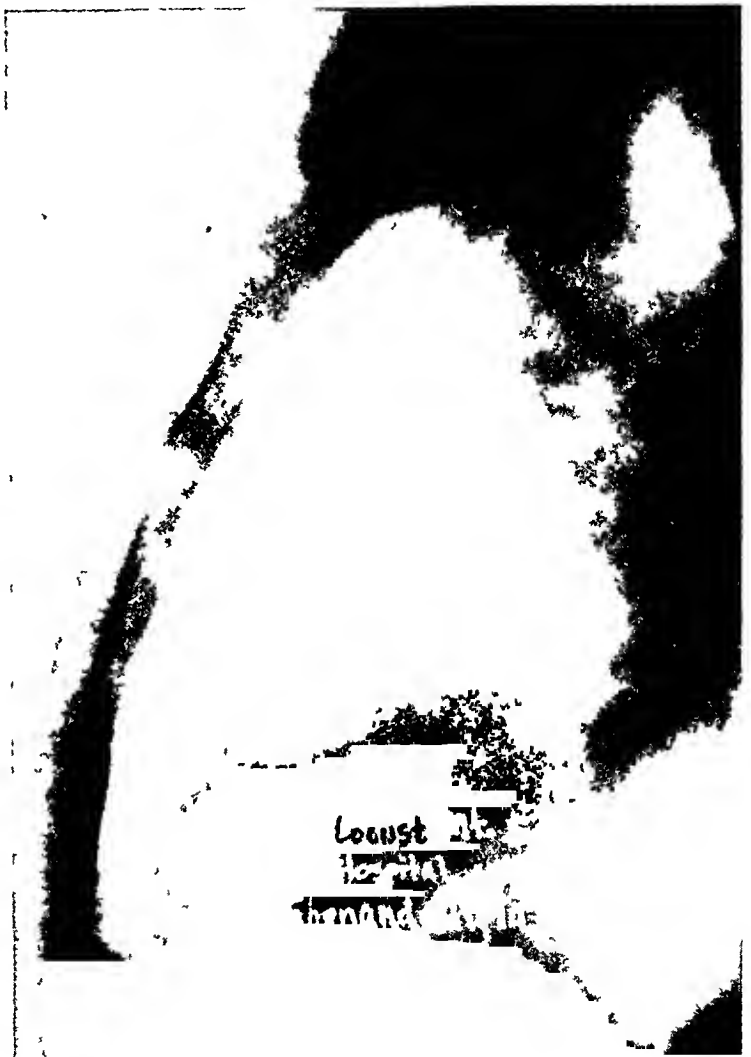


FIG 3—(Lateral view of chest) Showing an oblique fracture of the middle of the gladiolus with slight depression of the upper portion Fracture did not show in A P view

The prognosis is good in uncomplicated cases but decidedly bad when there are complications Fifty-four of Gurlt's cases were uncomplicated, with forty-six recoveries and eight deaths There were forty-four complicated cases with only one recovery

Repair with the formation of a bony callus takes place in from four to eight weeks There may be some degree of persistent deformity, depending on the thoroughness with which the fracture is reduced Occasionally bony

union fails to occur. This does not cause any serious disability other than temporary inability to abduct and adduct the arms.

According to Scudder,²² the fracture may sometimes be reduced by placing the patient on his back with the head extended over the end of the table, and then raising the arms above his head and rotating them outward slowly and forcibly. In the meantime, the patient's body is held by an assistant, thus the procedure described above makes traction and counter-traction on the two fragments.

After the fragments have been reduced, an adhesive plaster swathe is placed high up about the shoulder. It is held firmly in this position by straps across the shoulder. The patient must remain in bed for three weeks but may be allowed up occasionally thereafter, being careful, however, to avoid heavy exertion. A Taylor steel back-brace should be worn for two months thereafter as an additional precaution.

Operative treatment, according to Scudder, is frequently justifiable. An incision may be made and the depressed fragments elevated as soon as the shock of the original injury has passed away. In some cases cyanosis and dyspnoea are removed immediately the deformity is corrected.

When displacement is visible and painful and causes crepitus and pain at each inspiration, Speed²³ advises reduction by extending the spine and drawing the shoulders back during deep inspiration. This manipulation elevates the upper fragment so that the lower fragment or its attached ribs may be pressed on until the deformity is overcome. The reduction may be retained by placing a pad between the scapulæ and using a figure-of-eight bandage to hold the shoulders back.

Roberts and Kelly²⁴ state that an open operation is justifiable when reduction cannot be accomplished by manipulation. An incision is made over the seat of the fracture and the depressed fragment is elevated by any suitable instrument. After being replaced, it may be retained in position by a plate or nail or by direct suture with chromic catgut or silver wire. Although union takes place within eight weeks, it is advisable to have the patient wear for a few months a brace or a gypsum jacket similar to that used for fractures of the spine.

Stimson,²⁵ on the other hand, believes that, unless the displacement is causing dangerous symptoms, the open operation is not justifiable because of its risks. He cites two cases in which attempts at reduction by the open method were failures. In a case of fracture of the upper part of the sternum with depression of the lower fragment, an incision was made with the intention of introducing a hook, but the pleural cavity was opened accidentally and it was necessary to close the wound immediately. In the second case quoted, the upper fragment was raised to the proper level by screwing a sort of gimlet into it and drawing it forward, but unfortunately it sank partly back again and a second attempt to elevate it was frustrated by the tearing out of the screw.

REPORTS OF CASES

CASE I—A G, a miner, aged twenty, brought to the hospital in the Reading Coal Company ambulance, following an accidental squeeze between mine cars at Mahanoy City Tunnel Ridge Colliery, November 26, 1926, in shock and severe pain. On admission his temperature was 97.8, his pulse, 114, and respirations, 46, the face was deeply cyanosed as was the neck also, and his expression was anxious.

The physical signs pointed to a fracture or fracture-dislocation of the gladiolus at its junction with the manubrium, there were no fractures of the ribs. There was extreme tenderness over the spine and a beginning hæmatoma was in evidence. Because of the

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corpulence of the patient a definite diagnosis of fracture of the spine clinically could not be made, but with this suspicion in mind the patient was later X-rayed. There were no neurologic symptoms. The patient was treated for his shock in the Accident Receiving Ward before being sent to the ward.

X-ray examination No 927 revealed the following. There is no definite fracture of any of the ribs. There is no definite evidence of fracture in the region of the hips. Examination of the lumbar spine shows a compression type of fracture of the second lumbar vertebra, the under surface of the first and the upper surface of the third sharing somewhat in this compression. The spinous process of the first and second on the right side are fractured. There is no lateral displacement in the fracture of these vertebrae but the second is displaced backward on the third possibly a quarter of an inch. Examination of the sternum shows an anterior dislocation of the upper end of the gladiolus at its junction with the manubrium.

After all symptoms of shock abated the patient was placed on a Bradford frame on which he was fairly comfortable. The symptoms of his *traumatic asphyxia* did not disappear until after two weeks. The upper end of the gladiolus was pushed down by digital pressure and held in place with an adhesive swathe. The patient had a plaster jacket applied while in a Sayre suspension on December 30, 1926, which was removed and replaced by a celluloid jacket which laced up the front. This was made from the model of the plaster of Paris. He was discharged from the hospital February 7, 1927, as "well." He stated to me on leaving that he felt excellent.

Follow-up report from his referring physician, Doctor Seligman of Mahanoy City under date of May 7, 1927, stated that his condition was good and that he was improving, he judged his functional result to be 75 per cent. A later follow-up report from the doctor under date of August 6, 1927, reported his condition as good and his functional result 90 per cent. He has resumed light work and the patient informed me in September that he was playing foot-ball.

CASE II—A G, a miner, aged forty, brought to the hospital in the Reading Coal Company ambulance, March 14, 1927, with the history that that morning he was squeezed between a car and a fall of coal an hour before his admission, at St. Nicholas Colliery. At the time of his admission his temperature was 96.4, his pulse, 64, and respiration, 22, there was no cyanosis but he complained of intense pain over the entire front of the chest with extreme tenderness over the second portion of the sternum with slight deformity. Beyond the above findings and a slight subconjunctival hemorrhage of the left eye, the examination was otherwise negative. Admission diagnosis of fracture of the gladiolus was made and X-ray examination made immediately revealed the following:

Examination of X-ray plates No 1205 reveal an oblique fracture of the second piece of the sternum just below the middle. There is considerable depression of the upper fragment and some overlapping. The third piece is not attached to the second piece but this probably is a normal condition, the space being filled with cartilage.

After the patient was admitted to the Men's Surgical Ward, the overlapping was corrected easily by digital pressure and an adhesive swathe applied. He was bedfast for four weeks and was discharged as "improved" on April 29, 1927. He returned to our Surgical Dispensary for several weeks after his discharge.

X-ray examination No 1320, under date of May 9, 1927, revealed a fracture of the lower end of the middle piece of the sternum, the position satisfactory, and callus present. No follow-up reports were returned by this patient and as he had no referring physician, having been rushed to the hospital immediately following his accident, his condition at this time is not known except that his employer states that he is at his usual occupation of coal mining.

CASE III—J G, a miner, aged sixty-three, was brought to the hospital in the Locust Mountain Coal Company Colliery ambulance, March 21, 1927, at 3 25 P M, a few minutes after an accident at Weston Colliery where he was caught between falling timber and a breast of coal. On admission his temperature was 97.8, pulse, 70, and respiration, 26.

He complained of extreme pain in the chest, shoulder, and scalp. Examination in the Accident Receiving Ward revealed an extensive coal dirt contaminated laceration of the scalp, a bilateral inguinal hernia, extensive varicose veins, and a probable fracture of the sternum, a scar on the left leg from osteomyelitis of many years ago. Because of the extreme weakness and pain the patient was not disturbed but treated for his shock to which he responded nicely. X-ray examination that night, No. 1244, revealed an oblique fracture of the middle of the second piece of the sternum, not much displacement, and the position satisfactory. There was no evidence of fracture of the skull.

This patient was later removed to the Men's Surgical Ward and an adhesive swathe was placed over the area without any manipulation. The patient felt very comfortable after this and the following day his laceration of the scalp was repaired under local anesthesia. He was bedfast for three weeks and was discharged from the hospital as "improved", April 22, 1927. He made several visits to our Dispensary and is enjoying the comforts of his home and the community. He does not intend to return to mining but has retired on the advice of his large family, having had forty years of mining. His sternum is such that he could resume his former occupation. These three cases left the hospital alive and in good condition.

CONCLUSIONS

- 1 Statistics show that fracture of the sternum is exceedingly rare
- 2 Diagnosis is best made by X-ray in the lateral position
- 3 In proportion to other fractures, fracture of the sternum is more frequently seen in mining communities and must always be ruled in the diagnosis where injuries occur about the chest
- 4 The treatment is simple, satisfactory, and affords relief from a very painful condition

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TREATMENT OF FRACTURES INVOLVING THE ANKLE-JOINT

WITH SPECIAL REFERENCE TO THE USE OF THE PILLOW SPLINT AND EARLY WEIGHT-BEARING

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SINCE fracture of the tibia or the fibula, as the result of forced internal rotation of the foot, is extremely rare, nay, probably does not occur at all unless in the individual case the movement of internal rotation gives way to tibial flexion, there remain four separate mechanisms as the result of which fracture of the ankle-joint may occur. We thus have fractures of either tibia or fibula, or both, as the result of

- 1 Fracture by external rotation of the foot
- 2 Fracture by abduction (fibular flexion of the foot)
- 3 Fracture by adduction (tibial flexion of the foot)
- 4 Fracture by upward thrust

Those fractures due to upward thrust require reclassification depending upon whether the off-centre direction of trauma is forward, backward or to either side. Fractures of this group have a great tendency to be atypical and require consideration individually rather than as a class.

Although in all doubtful cases the fact of fracture must depend upon radiologic examination, the likelihood of fracture is usually clearly indicated. More important, however, than simple diagnosis of fracture is the necessity for an accurate diagnosis of the mechanism, whereby the fracture was produced. As a rule such a diagnosis can be made by an examination of the limb coupled with the patient's history as to the nature of the trauma. In any event the case, in which an exact diagnosis is not possible from a radiologic examination, must be extremely rare.

We are of the opinion that we are in a position to make two contributions from the Montreal General Hospital which make for better results in the treatment of fractures involving the ankle-joint. I refer to the employment of the pillow splint as a primary fixation apparatus and to the early ambulatory treatment of the case with weight-bearing.

The pillow splint has been employed in the Montreal General Hospital for the past twenty-five years, but to the author's knowledge its description has never been published.

The importance of accurate replacement of bone fragments, together with the relief of strain upon the injured ligaments, is appreciated by all surgeons. It is furthermore, I believe, now accepted that early—or if possible immediate—reduction is of paramount importance.

In a fairly large proportion of cases of fractures about the ankle-joint, the

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parts slip back into the normal position when the traumatizing force is arrested. In such cases it is evident that manipulation for purposes of reduction is not necessary, fixation in an over-corrected position of the foot alone is required. In those cases in which deformity is present, replacement of the bones and bone fragments in their normal position is accomplished by means of manipulation under an anæsthetic.

In our clinic, following reduction, the limb is placed in a pillow splint. For this purpose a moderately large, deep feather pillow is required, covered with a pillow slip made of sound, strong material. The leg is placed upon the centre of the pillow,

with the latter projecting about six inches beyond the heel. The pillow is made to encircle the leg commencing about, or better above, the knee and firmly secured under tension by means of safety pins passed in the long axis of the limb. Working from above downward toward the ankle-joint, safety pins are placed in this way at short intervals. In this manner lateral and circular compression is exerted, this is of value in limiting cedematous

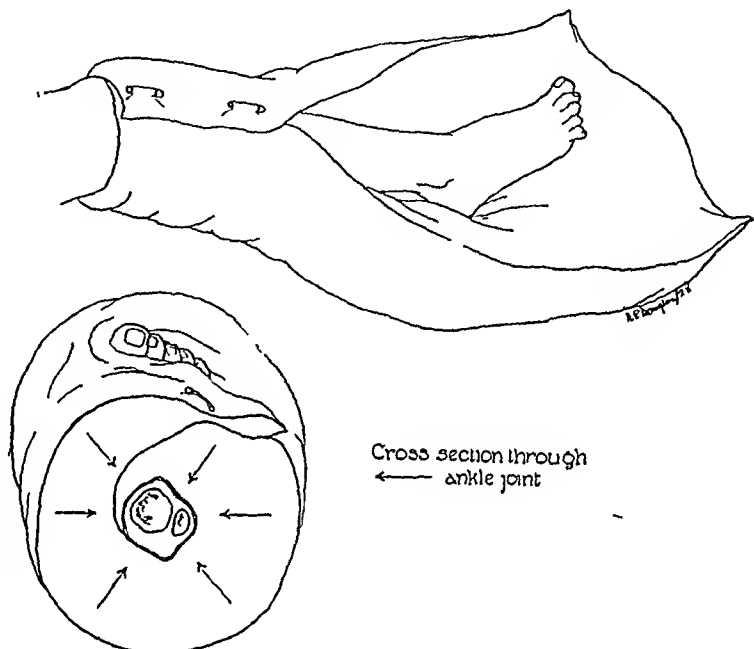


FIG 1.—Drawing showing position of the foot on the pillow at the commencement of application of splint. This drawing also shows the manner in which diastasis and swelling are overcome by the splint.

swelling and of forcing by gradual pressure, if reduction has been incomplete, displaced bones into position. Particularly is this useful in overcoming diastasis of the fibula from the tibia (Fig 1).

The projecting portion of the pillow below the foot is folded over the sole in such a way that the foot is forced into as marked dorsiflexion as possible, and in such a manner that abduction, or adduction, is induced as required (Figs 2 and 3).

The pillow splint in our hands has for many years proved efficient. It is, moreover, safe in that it is almost inconceivable that strangulation of tissue could be induced by its application, nor, if reasonable care be taken, is there any risk of compounding the severe type of case. It can readily be opened up for observation of the limb, and as a matter of fact must be readjusted several times during the first two or three days following its application.

Too great stress cannot be laid upon the fact that the pillow splint is, as the name suggests, essentially a pillow so placed under tension that it acts as a splint. The pillow itself is not used as padding and the frequent employment of a pillow placed about the limb with two or more longitudinal pieces of

wood fixed by means of strapping or bandaging to the outer surface of the pillow does not constitute a pillow splint. No other method of fixation of the pillow other than safety pins has proved successful, although it is, of course, evident that a special form of clamp similar to a towel clip might be devised to take the place of the safety pins.

The limb is allowed to remain fixed in the pillow splint for a variable number of days, the length of time being dependent upon several factors, more especially the severity of the injury and amount of swelling present.

As a permanent dressing for fractures about the ankle-joint nothing is

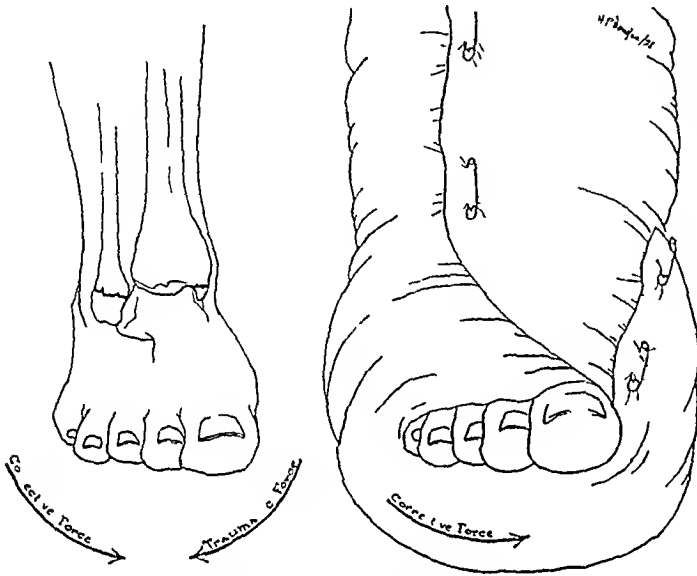


FIG. 2.—Drawing showing manner of employing a corner of the pillow to bring about correction of displacement in fracture due to fibular flexion.

so useful as plaster-of-Paris. It has been our custom to employ this material in the form of a cast fashioned with circular bandages. In the more severe type of case the first cast should fix the knee-joint in flexion. As a rule, however, plaster reaching from immediately below the knee to the base of the first three toes and covering the fourth and fifth toes suffices. If swelling has subsided, before the application of plaster, it is recommended that the

plaster be applied to the limb without the employment of padding.

Following immediate reduction of those cases showing evident deformity, X-ray examination should be made with the limb in the pillow splint. If adequate correction has been obtained the limb may quite profitably be allowed to remain in the splint for a period of days, until such time as swelling has subsided. Should radiologic examination prove that adequate reduction has not been obtained, further anaesthesia is required and an attempt made to completely overcome the residual deformity.

The first plaster-of-Paris fixation apparatus is allowed to remain in place for a period of about ten days. At the completion of this period the cast is removed, the posterior part preserved to act as a splint, and light massage, diathermy, baking and active movements employed. In the most severe type of case it is advisable to carry out physiotherapy for a period of three to six days at this time.

The limb is then replaced in a circular plaster often reinforced by a posterior moulded piece. No padding is applied, one layer of stockingette only is placed about the limb and the foot is fixed in as dorsiflexed a position as possible. After the plaster has dried, a heel approximately one inch in

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thickness is attached to the bottom of the cast by means of adhesive plaster. This heel is made of saddler's felt. The patient is then urged to commence weight-bearing upon the injured limb, either with or without the help of crutches or stick. In the application of this walking plaster, care must be taken to apply the bandages evenly and snugly to the limb. Particular attention must be paid to moulding the plaster accurately to the malleoli and to the tuberosities of the tibia and lower border of the patella. The body weight is to be borne directly from the heel on the plaster to the expanded upper end of the tibia and lower border of the patella, therefore care must be taken to ensure a perfect fit of the bucket which the upper end of the plaster constitutes (Fig 4)

Patients whose time is valuable have a boot made so that their deformity is less noticeable, and go about their business as soon as this second plaster is applied, that is, about ten days or two weeks after the more severe types of injury. In cases of oblique fracture of the lower end of the fibula due to

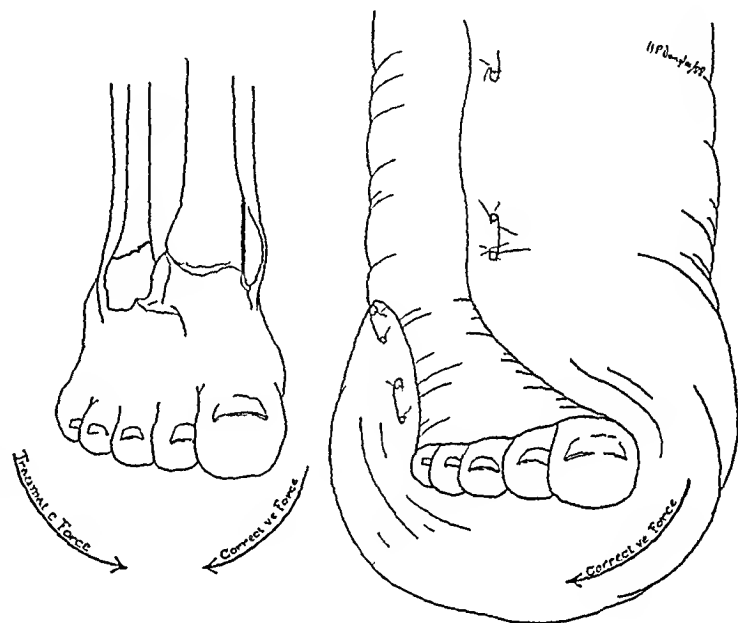


FIG. 3.—Manner of employing pillow in correction of deformity in cases due to tibial flexion

external rotation, the patient is usually able to walk without crutch or stick on the third or fourth day following injury. If a leather boot is to be worn, the heel is attached to the boot and not to the plaster.

The application of plaster-of-Paris in such a way that weight-bearing on the injured limb can be carried out soon after injury is whole-heartedly recommended. We have found the method free from disadvantages and are of the opinion that there are several great advantages pertaining to the employment of this technic.

It need not be explained that patients are pleased to be relieved from the irksomeness of confinement in bed or to the house, and that they appreciate being able to walk without crutches. It is also easily realized that many patients gain much by being able to return to work within a week or two after injury, particularly is this fact appreciated by one's private patients.

More important, however, in our opinion than the foregoing advantages is the fact that the end result obtained is more perfect than by other methods and that the period at which complete return of function of the limb is reestablished is shorter than when other more confining methods are employed. More particularly are we of the opinion that the occasional very troublesome, painful and disabling complication, namely bone atrophy, is avoided by making

it possible for the patient to commence walking early. Time does not permit, nor is the author prepared to enter into an argument as to the cause of bone atrophy following fractures, I am, however, of the opinion that disuse is of very considerable importance in the development and prolongation of

the condition. During the past few years many cases of bone atrophy have been seen by the author. All of them have been treated by methods other than that recommended in this contribution.

The more trivial type of case, in which originally no displacement has been present, may commence walking without support from five to eight weeks following injury.

In the more severe types of injury the plaster-of-Paris cast should be removed, and reapplied every ten days or two weeks with an interval of two or three days during which baking, massage and active movements are employed. These patients should not be permitted to walk without plaster in less than eight weeks. Very frequently it is advisable to maintain fixation for a period of twelve weeks following injury.

When the plaster is finally removed, except in those fractures due to abnormal adduction or tibial flexion, the patient is instructed to have the boot tilted. For this purpose the inner border of the heel and sole is raised a quarter, or three-eighths, of an inch. Limitation of dorsiflexion

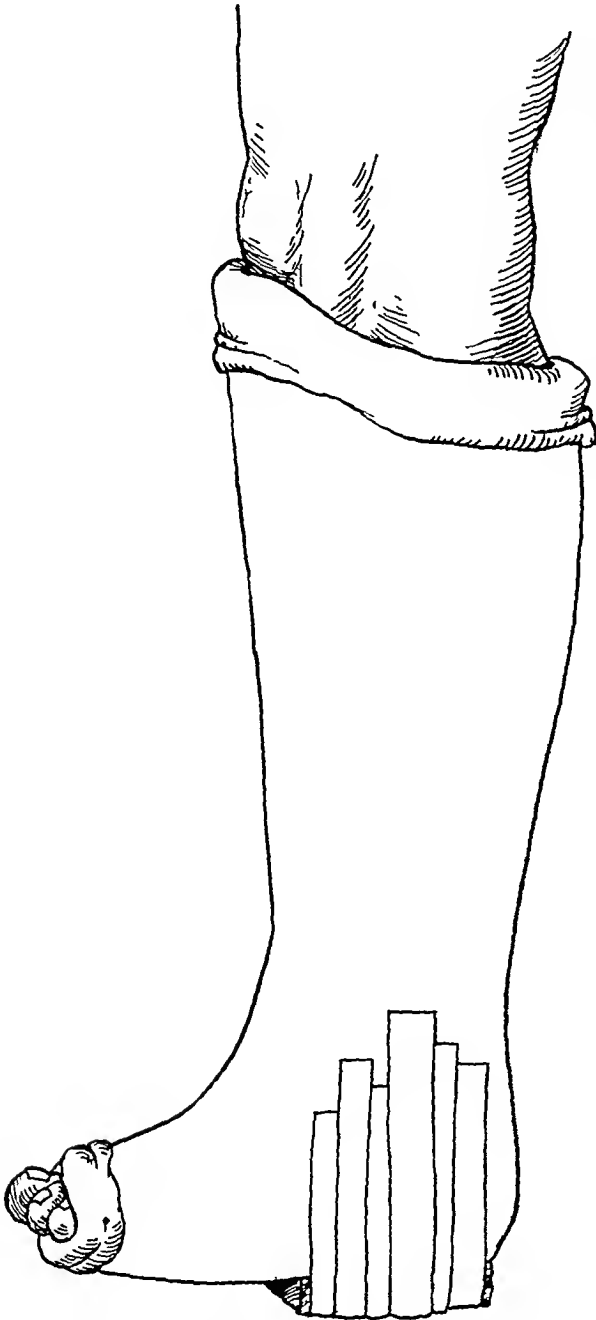


FIG 4—Showing application of walking plaster and application thereto of felt heel

is sometimes sufficiently marked to make it difficult for the patient to walk easily without externally rotating the limb. This tendency can be very considerably inhibited by raising the heel so that it measures one and one-half, or one and three-quarters inches in height. By this means several degrees of potential dorsiflexion is added and the patient is able to walk more comfort-

FRACTURES INVOLVING THE ANKLE-JOINT

ably and more properly. Inasmuch, moreover, as the longer of the two lower extremities is called upon to do less work than its fellow, there is a natural protection afforded, in this way, to the injured leg.

In a small proportion of cases of the most severe type, and in a somewhat larger number of cases in which for economic or other similar reasons, it is important that plaster-of-Paris be dispensed with earlier than would otherwise seem wise, the employment of a brace is indicated. For this purpose either a short caliper or an outside iron is suitable. Since the outside iron is light and performs the functions required in fractures following external rotation and abduction injuries, it is the apparatus more generally applicable. The patient wearing such an apparatus carries but little weight upon the foot or lower part of the leg, as the greater part of his body weight is directly transmitted from the boot heel to the tuberosities of the tibia. At the same time the limb is protected against torsion and bending strains.

The period of disability following fractures involving the ankle-joint, assuming adequate treatment of the case, is dependent upon, in the first place, the nature of the injury, and in the second place, the occupation of the patient. The more trivial injuries may return to practically normal function in about ten weeks following injury. In all the more severe cases at least three months is required and very frequently six months or more must elapse before the patient is in a position to return to any occupation in which the lower extremities are subjected to strain.

END RESULTS OF CARPALECTOMY *

BY B FRANKLIN BUZBY, M D

OF CAMDEN, N J

THE problem of how to handle injuries of the carpal bones is one that is far from being standardized. The small series here presented brings out a few pertinent facts which are sufficient to warrant further use of the operative treatment of these conditions.

The anatomy of the wrist is of some importance in deciding upon the method of procedure. There are eight carpal bones closely adherent to each other by means of a capsule extending from the forearm bones to the metacarpals with digitations from this capsule to each of the eight bones. There are thickened portions of the capsule forming the dorsal, volar, and lateral ligaments, and also transverse interosseous ligaments uniting the bones of each row of carpals, thus forming smooth articulations for the metacarpals and forearm bones. The radio-carpal, intercarpal and carpo-metacarpal synovial sacs inter-communicate so that hemorrhage and infection in one joint level is essentially in all. Most of the motion of the wrist-joint takes place in the radio-carpal articulation. Of a total range of 90 degrees of flexion and 65 to 70 degrees extension of an average wrist only 15 degrees is in the intercarpal joint. In estimating loss of motion, however, it is far better to compare the two wrists of the patient. Ordinary intercarpal motion is only in flexion and extension but the scaphoid itself is far more mobile than this which may be one of the causes of it being the most commonly injured carpal bone—86 per cent of 123 cases reported by Bizarro in *Surgery, Gynecology and Obstetrics*, May, 1922, and 64 per cent of 387 cases quoted by Speed.

The blood supply is obtained from small terminal branches entering the bones by means of the ligaments at or near the periosteum, and then these immediately spread out in all directions. This vascularity is scanty at its best thus explaining the cystic areas seen in old fractures. When a fracture occurs in the middle of a carpal bone the blood supply along this line is destroyed. Almost always there is a crushing of the fragments on either side of the fracture line. Here also the circulation is interfered with and in turn the viability of the entire bone is threatened or destroyed. Absorption of the non-vascular area takes place slowly, or if sufficiently damaged in the beginning the entire bone undergoes an avascular death and if left in place acts as a foreign body causing irritation to the surrounding soft tissues and bones. Due to lessened use the neighboring bones undergo atrophy and because of the irritation of the foreign body, pannus formation may appear. Ligamentous congestion and inflammation takes place, chronic effusion appears and periarticular limitation of motion ensues even including the tendons and sheaths. The grip becomes

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END RESULTS OF CARPALECTOMY

weak and painful. In carpal dislocations the blood supply of the involved bone is soon interfered with and even though the displacement is reduced, the bone in time is very apt to undergo necrosis. Pressure on overlying nerves by the fragment soon causes interference with the intrinsic musculature of the hand, which when it arises is always very slow in recovery. This same symptom takes place when too great efforts are used at reduction, especially in volar semilunar dislocations.

The fact that in practically all unrecognized or untreated carpal bone injuries and in many treated conservatively, the above pathological changes take place it is of considerable importance that these injuries be recognized early. Any trauma of the wrist incurred in a fall on the hand or one the result of a direct blow or auto backfire should make one suspect a carpal bone injury, and should adequate X-ray pictures be taken in two planes the diagnosis is clear. Clinical findings are of value also—*e g*, hyperextension of wrist is painful, often lacking, the grip is weakened and attempts cause pain in the wrist. Motion continues to be more limited as time goes on and the swelling does not subside. Direct pressure on the affected bone causes pain which persists for a while after the pressure is relieved. In dislocations of recent origin there is an abnormal prominence on one aspect of the wrist, and a depression on the other with limitation of motion in all directions. It is most difficult to accurately diagnose a combined injury to two or more carpal bones but since it is sufficient to recognize the need of a roentgenogram, by this means we will be set straight as to diagnosis.

The operative treatment of carpal bone injuries can best be done using an Esmarch band and then by means of a longitudinal incision over the affected bone, careful exposure and division of the annular ligament, gentle retraction of tendons in their sheaths and incision through the capsule exposing the desired carpus. The proximal fragment of the scaphoid as a rule is easy to deliver but the distal portion seems very tenacious, especially where it is firmly attached to the lateral ligament of the wrist. If the necessary cutting or blunt dissection of the ligamentous attachment is carried out using the bone to be removed as a buffer, no damage is done to the blood supply or synovial membrane of the surrounding bones. The wound is closed in layers, a rubber tissue drain is inserted and a plaster splint is applied with the wrist in 30 degrees of extension, the position described by some as that assumed by the wrist when one grasps a tumbler.

The drain is removed at the first dressing in three or four days and the splint done away with after eight to ten days when active motion and physiotherapeutic treatment are begun. In recent cases motion is returned almost to normal and in old cases motion is greatly increased. In both types of cases pain on motion and on gripping is done away with. In any event it is the pain rather than lack of motion which is so disabling to the patient.

In a series operated upon by the writer at the Cooper Hospital, Camden, N. J., six were done within a week of the injury and four were done at periods of from seven weeks to six months after the original injury. Many other

late cases have been seen and advised operation who have refused or who have gone on to another clinic for care. Many early cases with fractures which appear incomplete roentgenologically or which appear to be merely sprain fractures, or very early dislocations easily reduced, have been seen and treated conservatively.

Speed in his monograph on "Traumatic Injuries of the Carpus" gives several positive statements which can be followed without argument (1) All cases of old dislocations of carpal bones should have carpalectomy (2) All cases of old fracture with displacement of fragments should have operation and removal (3) The entire bone involved should be removed (4) Conservative treatment should be tried first for a long period in adolescents.

Going further, it would seem that conservative treatment should be reserved for those patients with sedentary occupations. In all other cases operative treatment ought to be instituted early because the period of time loss is about equal in the two methods, and as it too often happens after conservative treatment the wrist is weak and painful and operation must be done with a double loss of time, to say nothing of the fact that the longer the elapsed period from injury to operation, the less likely we are to get a satisfactory result.

Case	Age	Occupation	Diagnosis	Cause
(1) I M	29	Carpenter	Comminuted fracture trapezium	Direct blow
(2) H M	32	Laborer	Fractured scaphoid	Fall on hand
(3) L D	38	Laborer	Fractured scaphoid	Fall on hand
(4) A T	27	Foreman	Comminuted fracture scaphoid	Fall on hand
(5) I S	35	Salesman	Fracture cuneiform Dislocation semilunar	Auto backfire
(6) P H	19	Patternmaker	Fractured scaphoid	Fall on hand
(7) L T	48	Retired	Dislocation semilunar	Auto accident
(8) C K	24	Laborer	Fractured scaphoid	Fall on hand
(9) J S	22	Prize fighter	Fractured scaphoid	Striking 150-lb sand bag with fist
(10) R B	18	Student	Fractured scaphoid	Fall on hand

All but Cases 4 and 5 had complete removal of the affected bones. The former had excision of the proximal fragments of the scaphoid and the latter had the cuneiform removed and the semilunar replaced. These two alone have pain and that only on forced motion. Even these have a normal painless grip.

End Result

Recent Cases

Case	Injured date	Operation date	Time lost from work	Lost motion as compared to other hand	Pain
(1) I M	6/26/23	6/29/23	10 weeks	none	none
(2) H M	8/1/23	8/6/23	7 weeks	30 degrees extension in 4 months	none
(3) L D	8/30/23	9/3/23	7 weeks	none	none

END RESULTS OF CARPALECTOMY

End Result

Recent Cases —Continued

Case	Injured date	Operation date	Time lost from work	Lost motion as compared to other hand	Pain
(4) A T	9/12/24	9/15/24	1 week	15 degrees flexion 10 degrees extension 10% disability	slight on forced motion
(5) I S	10/20/26	10/22/26	9 weeks	15 degrees flexion 20 degrees extension 15% disability	moderate on forced motion
(8) C K	9/25/27	9/30/27	6 weeks	20 degrees extension in 5 months	none

Old Cases

(6) P H	10/20/26	12/6/26	8 weeks	none	none
(7) L T	12/14/26	2/3/27	7 months	50 degrees extension	none
(9) J S	7/10/27	10/31/27	6 weeks	none	none
(10) R B	8/15/27	2/16/28		30 degrees extension 30 degrees flexion	none

ACUTE HÆMATOGENOUS OSTEOMYELITIS *

THE RELATIONSHIP OF ITS PATHOLOGY TO PROGNOSIS AND TREATMENT

BY FENWICK BEEKMAN, M D

OF NEW YORK, N Y

ACUTE hæmatogenous osteomyelitis is a suppurative, inflammatory process in a bone, the infection being deposited through the circulation. Consequently, for the development of a focus of osteomyelitis, it is necessary that there be bacteria circulating in the blood and that there be a point in the bone where the conditions are such that the bacteria may lodge and grow.

Undoubtedly at many times, during one's life, bacteria are freed from some focus into the blood stream, but usually they come to nought as they are disposed of by the various bactericidal agents of the blood and body cells before they can find a suitable place for lodgement (Martin). Thus a bacteriæmia does not mean necessarily that the bacteria are constantly in the blood stream.

A focus may free bacteria into the circulation only once, in an intermittent manner or continuously, or possibly the bacteria having once gained access to the blood stream may propagate there.

The focus from which bacteria enter the blood stream may be in any part of the body. It is probably most frequent for the bacteria to gain entrance to the circulation from the surface of an infected thrombus, as one in a superficial vessel near some inflammatory process in the skin or mucous membrane.

The severity of a bacteriæmia depends on the one hand on the virulence of the bacteria and the number of microorganisms set free in the blood stream, and on the other on the amount of resistance of the body.

Although in most cases of bacteriæmia the microorganisms are only transiently in the blood stream, nevertheless in some there may be lesions which free the organisms continuously, as in the case of a thrombus in some large vessel, or the bacteria having gained entrance to the circulation a secondary lesion is established within the circulation as upon the surface of the endocardium.

Some writers consider the term septicæmia to mean a condition where there is a constant circulation of bacteria in the blood stream. This definition appears to be vague and for clearness of understanding the term bacteriæmia will be used, at this time, to denote all cases where bacteria are actually found in the circulation, and the term septicæmia will only be used to denote a clinical entity, where the symptom complex is caused by a bacteriæmia, in which the symptoms of the blood infection overshadow in intensity the signs of any local condition which may be present.

It is presumed that when a secondary focus is started in the body, whether

* Read before the New York Surgical Society, April 25, 1928

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it be in the soft parts or bone, that it may become the point from which bacteria may enter the circulation, as well as from the primary focus. Thus a bacteriæmia may be continued from either of these foci or both, and any further local lesion which develops whether it be in bone or soft parts may be a metastasis from either.

If during the period in which bacteria are in the circulation some of them are deposited at a point in the body where the local resistance is lowered and conditions are favorable for their growth, a focus is established, and if this point is within a bone, osteomyelitis develops.

If the bacteriæmia producing an osteomyelitis is only transitory and the new focus, within the bone, does not produce a secondary bacteriæmia, the condition will be only that of a local infection within a bone. However, if the bacteriæmia is continuous, resulting from either the primary point of invasion or the secondary lesion, the condition becomes one of a generalized blood infection complicated by an infection within a bone. In the latter case the septicæmia must be recognized as well as the osteomyelitis.

To understand the lodgement of bacteria in a bone and the development of an osteomyelitis, it is necessary to have some knowledge of the anatomy of the bones.

The fact that certain types of bones are involved more often than others and that the pathological process usually starts at a given point in them, leads us to the belief that the anatomical structure of this point, in these bones, is such that under certain conditions the bacteria are able to gain access to the tissues

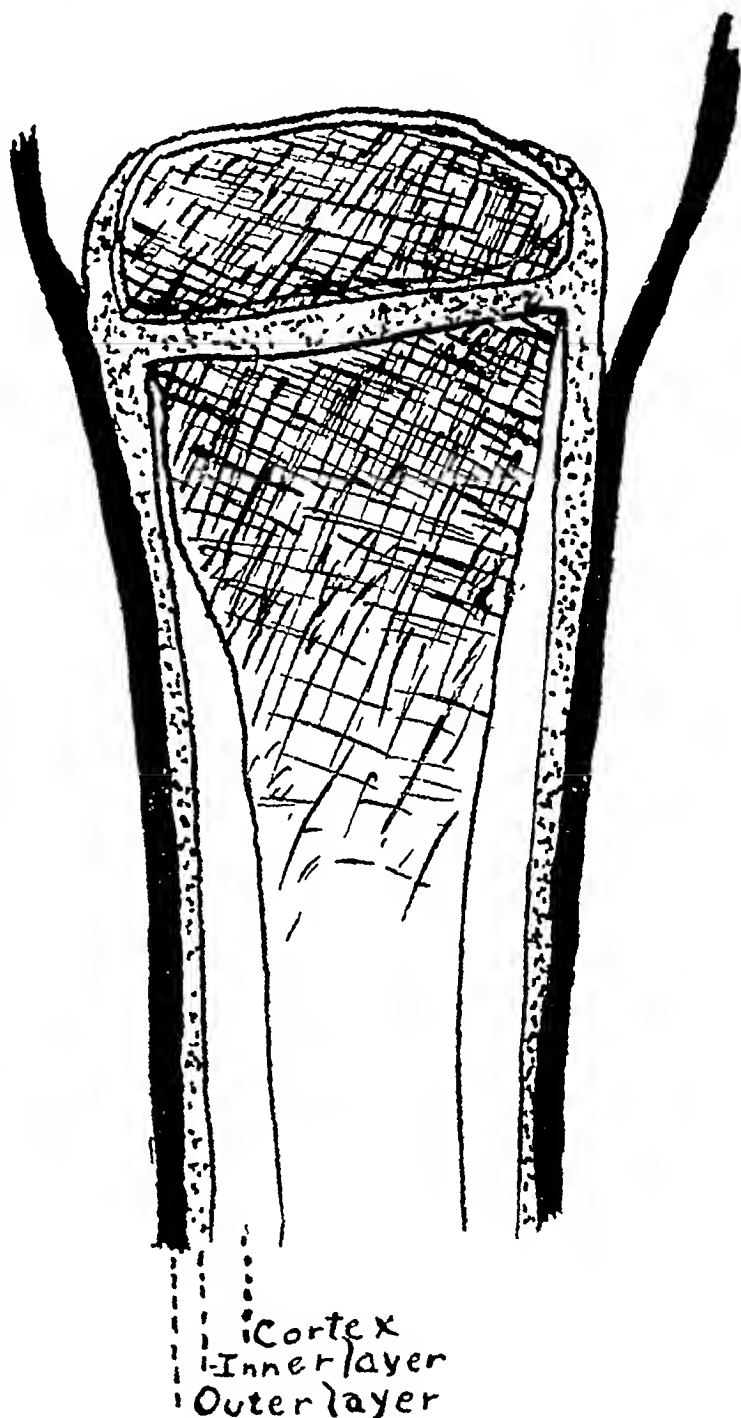


FIG 1.—Schematic drawing, showing relation of layers of periosteum to epiphyseal line, and epiphyseal line to joint

and start a lesion. It will be shown that the long bones are much more often affected than the flat or small bones, and that the ends of the diaphysis are the points at which the lesion is usually situated.

The long bones of the skeleton are developed from embryonal cartilage in which centres of ossification develop. At the time of birth the diaphyses of the bones are entirely ossified, while the epiphyses, with the exception of those at the lower end of the femur and upper end of the tibia, are still entirely cartilage. One or more centres of ossification develop in the cartilage of the epiphysis, finally ossifying the entire end of the bone except for a narrow cartilage which separates it from the diaphysis, and is known as the epiphyseal cartilage, and a cap of cartilage on its extremity which becomes the articular cartilage.



FIG. 2.—Hip joint. The epiphyseal line of the femur is entirely intra-capsular.

The epiphyseal cartilage is made up of successive layers of cells. The layers toward the epiphysis are composed of a hyaline cartilage matrix in which are found irregularly-scattered cells with deep-staining nuclei which show numerous mitotic figures. This layer adds slightly to the epiphysis to produce its growth, but its main function is in supplying new cells for the columns of cartilage cells which form the remaining layers of

the conjugal cartilage. Growth takes place from the diaphyseal side of the cartilage by proliferation of the cells in its successive layers. The cartilage cells in the outermost layer being absorbed and replaced by bone in the epiphyseal end of the diaphysis. Thus, Ollier found that the excision of the epiphysis itself, leaving the conjugal cartilage, resulted only in a slowing of the growth of the bone, the cartilage still proliferating and producing new osseous tissue.

Haas has shown, experimentally, that the cutting off of the entire blood supply to the epiphysis results in a marked lessening of the longitudinal growth of the bone, that if the nutrient artery is destroyed there will be practically no change in longitudinal growth, as long as the circulation to the epiphysis is intact and that if both the circulation to the epiphysis and the nutrient artery are destroyed, at the same time, there will be a greater loss of growth than if only the former circulation is cut off. From these facts he reasons that, "The maintenance of the normal longitudinal growth of bone is dependent upon a sufficient blood supply to the region of the epiphyseal cartilage line."

In further experiments, to prove the localization of the growing point in the cartilage, Haas came to the conclusion that a separation in the natural line of cleavage between the epiphysis and metaphysis caused some loss in growth, that the excision of the metaphysis caused a very slight disturbance to growth, and that the excision of the epiphyseal

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cartilage caused practically a cessation of growth. He concluded that, "The most active and important elements necessary for longitudinal growth are located in the columns of cartilage of the epiphyseal cartilage plate."

The diaphysis of the bone is composed of a shell or cortex which surrounds a partly-hollowed centre which is known as the medulla, for clearness in description the diaphysis may be arbitrarily divided into a shaft and a metaphysis at either end.

The cortex is made up of compact bone which is formed of lamellæ or sheets of bone, which are placed in concentric groups surrounding the Haversian canals, which carry the blood-vessels. The blood-vessels enter the Haversian canals in the compact bone, both from its outer surface and from the medulla. The cortex of the long bones is thickest in the mid-shaft of the diaphysis and becomes thinner as the metaphyseal region is approached, where the bone broadens out.

The medulla at the end of the diaphysis is composed of a network of trabeculæ or scaffolding of cancellous bone, which forms numerous cell-like marrow cavities. As the shaft of the diaphysis is approached, the cavities grow larger and less numerous, until one large cavity is formed, which is known as the medullary cavity. The medulla contains the marrow, a highly specialized vascular tissue, and blood-vessels, together with fat. There are lymphatic trunks accompanying the vessels.

The portion of the diaphysis in contact with the epiphyseal cartilage is formed of soft spongy bone, it is red in color and very vascular, it is known as the *juxta-epiphyseal* region of Ollier. This is the active area of new bone formation, resulting in the longitudinal growth of the bone.

The attachment of the surface of the epiphyseal cartilage to the diaphysis is insecure, the cartilage being held in relation to the metaphysis by the periosteum. Thus separation of the epiphysis almost always takes place through the *juxta-epiphyseal* region, and injury to this region may result in a retardation of the longitudinal growth of the bone.

The bones are closely invested by the periosteum, which is composed of two layers, an inner or osteo-genetic and an outer or fibrous layer. The periosteum covers the entire diaphysis and is easily detached except where ligaments, tendons or aponeuroses are attached. In the young it is a thick vascular membrane, but later becomes thin and more firmly attached to the bone.

The inner or osteo-genetic layer is continuous with the epiphyseal cartilages at either end of the bone, the cartilage appearing to be a massive expansion of this layer of the periosteum. This layer produces the concentric growth of the diaphysis. As it is attached to the conjugal cartilage, it does not extend continuously upon the epiphysis. The osteo-genetic layer surrounding the epiphysis is also continuous with the conjugal cartilage, the two portions extending from the cartilage like the arms of a Y. The fibrous layer of the periosteum is made up of bundles of fibrous tissue, it acts as a protection to the delicate cells of the inner layer, and helps support the blood-vessels which perforate it. It is continuous with the peri-articular ligaments at the ends of the bones and when attached to the epiphysis is the principal bond of union between it and the diaphysis.

The articular cartilages capping the ends of the epiphyses are composed of hyaline cartilage, and are the remains of a portion of the cartilaginous epiphyses which have not become ossified. The synovial membrane which lines the joint cavity extends over

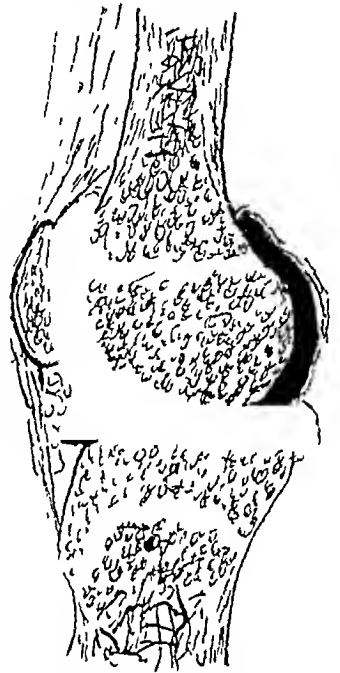


FIG. 3.—Knee joint. The epiphyseal line of the tibia is entirely extra-capsular. The epiphyseal line of the femur is intra-capsular on its anterior and posterior aspects, and extra-capsular on its lateral surfaces.

the surface of the articular cartilage for a short distance, but is absent where the cartilages come in contact with each other

The relationship of the attachment of the capsule of the joint to the epiphyseal cartilage differs in each joint. If the ligaments are attached to the bone proximal to the epiphyseal line, the entire epiphysis is intra-capsular, as in the head of the femur. If they are attached distal to the cartilage, the epiphyseal line is entirely extra-capsular as found in the upper end of the tibia. In many joints the epiphyseal line is intra-

capsular on one aspect and extra-capsular on another, as in the lower end of the femur, the lower end of the bones of the leg, the upper end of the humerus and the bones about the elbow and wrist joints.

The long bones, in growing individuals, receive their blood supply from three different sources. A single nutrient artery to each bone perforates the cortex of the shaft at about its mid-point, passing through the nutrient canal. (The femur has two nutrient arteries.) On reaching the medullary cavity it divides into ascending and descending branches to supply either end of the bone. These give off lateral branches which enter the Haversian canals of the cortex, anastomosing with branches from the periosteal vessels. The main branches of the nutrient artery finally end

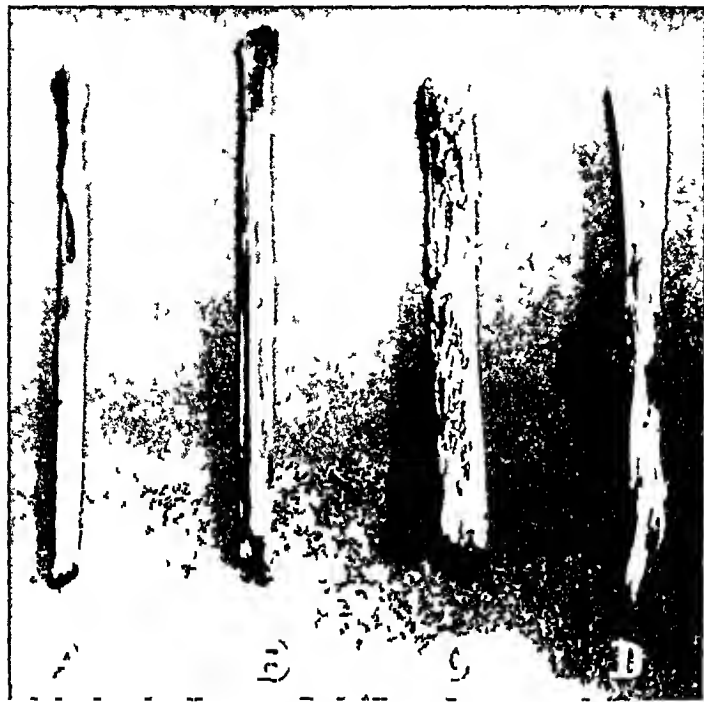


FIG 4—A Sequestra of shaft of fibula removed soon after separation. Note lack of absorption of bone. B Sequestra of shaft of fibula removed early in disease. New shaft failed to form in this case. C Sequestra of shaft of tibia showing slight absorption. New shaft failed to form. D Sequestra from shaft of tibia involving only two thirds of circumference of shaft although the contents of the medullary cavity, in this case, was totally destroyed.

just short of the *juncta*-epiphyseal region in terminal branches which form venous loops in which the circulation is slowed. The cortex of the shaft of the bone is also supplied with blood from a network of arteries in the periosteum. These enter the bone through the Haversian canals, opening on the cortex, and supply the outmost lamellæ of bone. The periosteal vessels are short, but they anastomose with the vessels which enter the cortex from the medulla. Lexer has shown that in the metaphysis the periosteal vessels, which are larger, perforate the thin cortex supplying the portion of the metaphysis which is in relation with the epiphysis. Lexer described an avascular area in the metaphysis between the terminal vessels of the medullary circulation and the perforating periosteal arteries. But more recent investigators believe that the periosteal vessels anastomose with the lateral branches from the medullary.

The epiphysis receives its blood from vessels derived from the capsular arteries and from those in the periosteum, these perforate its thin cortex. While the epiphyseal cartilage exists, there is no communication between the vessels of the diaphysis and epiphysis within the bone. The conjugal cartilage has no blood-vessels. (The head of the femur, being entirely intra-capsular, receives its blood through the round ligament.)

The amount of circulation to any tissue depends upon the metabolic activity or work demanded of that tissue, the cortex of the bone being made up of an inert tissue, only needs nutrition enough to keep it alive, and produce its relatively slow concentric growth,

ACUTE HÆMATOGENOUS OSTEOMYELITIS

while the metabolism of the marrow and the tissues of the *juxta-epiphyseal* region are very active, the former in generating new blood cells and the latter in producing the longitudinal growth of the bone, consequently the blood supply to these tissues is plentiful

The amount of growth that takes place at either end of a bone is not the same. The canal for the nutrient artery enters the bone in an oblique manner. One explanation given for this is that the inequality of growth, at either end of the bone, causes a shifting of the periosteum, which draws the proximal portion of the nutrient artery toward the more rapidly-growing end.

The epiphysis, toward which the nutrient artery is directed, is the last to form centres of ossification, and is the first to join the diaphysis, and is consequently the end of the bone in which the least growth takes place. These epiphyses are the upper ends of the femur, and the bones of the forearm and lower ends of the humerus and bones of the leg.

The bacteria causing acute hæmatogenous osteomyelitis are the staphylococcus, streptococcus, pneumococcus, bacillus of influenza and the typhoid bacillus. The staphylococcus pyogenes aureus is most commonly found associated with this condition. Normally this organism is found in the skin and in other parts of the body. It may enter the circulation through small abrasions or wounds in the skin or mucous membranes, often without producing marked signs of inflammation at its points of entrance. Frequently the opening in the skin may be healed at the time of the onset of the osteomyelitis. Occasionally acute hæmatogenous osteomyelitis is preceded by a furunculosis. Lexer thinks that the common association of the staphylococcus aureus with osteomyelitis is probably due to the fact that it forms in clumps, which are more apt to be stopped in the loop of vessels in the metaphysis, and that the aureus is more often found than the albus, as the primary lesion is more commonly of the former variety. Robertson believes that the staphylococcus has a preference for the marrow cavities of bones.

MacCallum states, "The streptococcus seems to be able to enter readily into the blood stream by the aid of the lymphatics." Sore throats may precede lesions in the bone caused by the streptococcus hæmolyticus, or the osteomyelitis may be associated with a general pyæmia produced by this organism. During the severe epidemic of influenza in 1918, osteomyelitis at times complicated the disease. The organism recovered from the bone lesion was usually the streptococcus, but occasionally pure cultures of the bacillus of influenza were reported.



FIG 5 —Brodie's abscess, lower end of radius

Rarely during the late febrile period or convalescence of typhoid fever, osteomyelitis may develop, most often in the ribs, tibia or femur, and cultures from the bone involvement may show the bacillus typhosus

The staphylococcus is usually recovered from the osteomyelitis which complicates the exanthemata

Acute hæmatogenous osteomyelitis is not a particularly common disease Sutton reports that among 3,634 total admissions to the Hospital for Sick Children at Brisbane there were fifteen cases of this condition, an incidence of 4 per cent On the Children's Surgical Service, Bellevue Hospital, during the last three years, there have been twenty-seven cases of acute osteomyelitis in 3,751 admissions, an incidence of 7 per cent

Osteomyelitis of this type is a disease found preeminently during childhood and adolescence, though occasionally a case is seen during the third decade of life Speed, from a general service, reports 90 per cent of his cases occurring in individuals under fifteen years of age Pfeiffer's cases were divided according to age as follows Six below five years, twelve between five and ten years, and seventeen between ten and fifteen years The average was ten years Doran and Brown in an analysis of cases in children up to the age of twelve years report 74 per cent of their cases in children older than six Thus it is seen that the disease attacks the bones of individuals who are undergoing active growth This is explained by the anatomical structure and physiological conditions found in the bones at this time of life, which afford the conditions necessary for the deposition and growth of bacteria in these locations

Boys are subject to osteomyelitis almost twice as commonly as girls Pfeiffer had fourteen cases in male and eleven in female patients in his series, and Doran and Brown had forty-four boys and twenty-seven girls The skin of boys is more subject to mild infections, they are not as cleanly as girls, they are more prone to have cuts, scratches and abrasions, and at puberty they often develop acne and furunculosis, any of which conditions may become the primary focus for a bacteriæmia In addition, boys are more subject to exposure, to wet and cold and are much more apt to receive injuries such as bruises and strains

From the clinical and pathological findings observed in patients suffering from acute hæmatogenous osteomyelitis, it is evident that the metaphysis or juxta-epiphyseal region of the diaphysis is the portion of the bone that is commonly involved Starr and Robertson recently have shown this quite conclusively But occasionally the medulla of the shaft or even the epiphysis may be the point in the bone which is first attacked It has been stated that a primary suppurative osteomyelitis of the epiphysis never occurs However, three such cases have been observed, one of which was proved by pathological examination to be an acute primary epiphysitis caused by the staphylococcus aureus Such cases, however, would appear to be exceptions to the rule, that acute hæmatogenous osteomyelitis starts in the juxta-epiphyseal region of the diaphysis

The bacteria are thought to reach the juxta-epiphyseal region through the medullary arteries of the diaphysis or as Lexer states, through the periosteal perforating arteries of the metaphysis. Their progress is said to be retarded in the juxta-epiphyseal region by the physiological slowing of the current of the blood stream in the vascular loops found in this portion of the bone. Lexer states, "That the mechanical condition provided in the epiphyseal zone of growing bone, in which there is a physiological hyperæmia with a slowing of the blood stream, and by the arrangement of smaller vessels, and capillary loops with their branches which pass down into the primary medullary spaces of the epiphyseal cartilage, favor the disposition and retention of bacteria and explains the frequency of acute suppurative lesions in this point of the bone."

The apparent lack of phagocytic action, against invading bacteria, of leucocytes in the metaphysis, may also account for the more common location of the lesion in the ends of the diaphysis. If the staphylococcus aureus be injected into the circulation of young rabbits, the organism will be found among other places in the shaft, metaphysis and epiphysis of the long bones. In a few hours active phagocytosis is taking place within the medullary cavity and the epiphysis, but no leucocytes containing bacteria are found in the metaphysis. Robertson reports the following result of his experiments on rabbits:

1 "Organisms introduced into the blood stream are deposited, among other places, in the long bones."

2 "In bone there is very active phagocytosis, except in the metaphyses."

3 "Organisms produce inflammatory centres in metaphyses independent of trauma."

4 "It is impossible to produce a general infection of the medulla by a simple inoculation of organisms in the blood stream."

5 "Trauma may determine a local infection."

6 "Growing bones develop abscesses of the type of osteomyelitis within their metaphysis. Adult bones do so but rarely. In presence of a bacteriæmia, adults may produce an arthritis."

O. Uffreduzzi believes that the location of an infection in a bone is dependent upon the amount of activity in growth of the different parts of the bone, that in the first two or three years of life the chief activity of growth is taking place in the epiphysis, that is, the cartilage of the epiphysis is being absorbed and replaced with bone, consequently there is an increased blood supply. He thinks during this period infection most often attacks the epiphysis. In the later years of life, from five years on to adolescence, the greatest activity of growth is seen in the metaphysis, and that accounts for the fact that infections during this period are located in the ends of the diaphysis. He goes on further to state that the metaphysis, which is most frequently attacked, is the one at the end of the bone which shows the greatest activity in growth. His theories are of interest, but have not all been borne out by the clinical cases seen.

In addition to the facts already presented, it is probable that a pathological change must occur within a bone, to predispose a specific metaphysis to

infection In other words, there must be formed a "*locus minoris resistentiae*" Cold, exposure, debilitation from infectious diseases are all given as possible predisposing causes, and may have somewhat to do with lowering the general resistance of the body, but local trauma appears to be the agent which most often renders susceptible a point in a given bone to the infection A history of injury to the part is obtained, in a large number of cases This



FIG 6—Pathological fracture through the lower metaphysis of the femur, two weeks after the onset of the disease Suppurative arthritis of knee joint

is usually a story of slight direct violence, as a kick, or a bruise from a fall, but occasionally the patient may tell us that he "strained his leg" from jumping or running Pfeiffer, in his report of thirty-five cases, obtained a history of trauma in 43 per cent Bancroft states that in eleven cases, 60 per cent received injuries, varying in time from ten hours to two weeks, before the onset of the acute process A child has been seen by us, who had the lower epiphysis of his radius dislocated, which was reduced, and two days later returned to the hospital with an osteomyelitis in the metaphysis from which the epiphysis had been dislocated

The predisposition of a bone to infection with the staphylococcus by trauma can be produced experimentally, as shown by Robertson, and Zinsser states, "Intravenous injections of virulent staphylococci preceded by injury to a bone is often followed by the development of osteomyelitis"

Direct violence to or a twisting of the limb, by which a slight movement of the epiphyseal cartilage, on the metaphysis, is produced, causes the rupture of some of the small vessels of the metaphysis, thereby interrupting the blood flow in them and producing a hæmatoma With this obstruction to the passage of blood through the vessels, and

an extravasation, there is formed a point favorable for the lodgement and growth of any bacteria that may find themselves in the region

Robertson believes that the type of injury producing conditions favorable for the development of osteomyelitis must be one that results in a movement of the epiphysis upon the surface of the metaphysis, and that this is the result of traction upon the epiphysis through the ligaments which are attached to it. This may be one of the explanations of the frequency of osteomyelitis in the upper end of the tibia, as all of the ligaments of the knee-joint are attached to the epiphysis, and the joint being immobile except to flexion, any forced motion of rotation, abduction, adduction or extension, will be transmitted to the epiphysis. These same restraining ligaments are for the most part attached to the diaphysis of the femur, and consequently movements of its epiphysis upon its shaft are not as likely. It is more difficult to ascribe an injury by this method to the upper epiphysis of the femur, as this part of the bone is entirely intra-capsular, and the only ligament attached to it is the relaxed round ligament.

The bones of the lower extremity are involved far more often than those of the upper. Infection of the tibia occurs in about a third of all the cases, while the femur is involved in approximately a fifth, then follows in order of frequency the humerus, the fibula and the radius and ulna. The reason for the more frequent involvement of the long bones of the lower extremity is that they are much more subject to injuries than those of the upper. These facts may also be used to advantage to strengthen the view that trauma is a predisposing factor in the production of this disease.

The individual metaphysis attacked varies with the bone. As a general rule, it is stated that the end of the bone whose epiphysis is the last to join the shaft is the one most frequently involved, the ends of the bones of the lower extremity which form the knee-joint, and the ends in the upper extremity which are distal from the elbow-joint. Starr found the upper end of the tibia the most common site. Doran and Brown had eighteen cases of the lower end and but eleven at the upper, and Pfeiffer had ten of the former and only one of the latter. Nevertheless, most writers state that the upper metaphysis of the tibia is the commoner site in the majority of cases. The lower end of the femur is involved about three times as often as the upper. In the upper limb the upper end of the humerus and the lower end of the bones of the forearm are the joints of election.

Multiple bone involvements are seen in about 15 per cent of the cases (Speed 16 per cent, Pfeiffer 9 per cent, Doran and Brown 14 per cent). It is not usual to have two bones involved at the onset of the disease, however, a secondary involvement may develop within a few days or a week. At times the period between the onset of the first bone infection and the second is even longer than this. In a few cases secondary involvements of bones are stretched over periods of many years. A case may be mentioned of a boy of fifteen years of age, who had had five different bones attacked since the onset when ten years old.

In those cases in which secondary bone involvement takes place, the amount of damage done the bone and the severity of the symptoms are not as great in the later attacks as in the first. It appears that the body becomes partially immune to the organisms. It is interesting to speculate as to the origin of the bacteria causing a secondary bone involvement. We presume that they come from the blood, as in the case of the primary bone involvement, but do they enter the blood stream from the original focus or from one of the secondary lesions? With our present knowledge it is impossible to say which focus they come from, but it is conceivable that either may be the origin of the new bacteriæmia, producing the metastasis. Wilensky states that preceding a metastasis there may be a lightening up of the local symptoms in one of the old lesions, and that the bacteria producing the new focus enter the circulation from this lesion of renewed activity.

In considering the pathological changes which may take place in a bone infection of the type of hæmatogenous osteomyelitis, there are several factors which must be borne in mind. The

FIG. 7—Early suppurative arthritis of knee joint following small lesion in the lower metaphysis of the femur

first is that it is not an infection of a single tissue—i.e., bone—but of a structure composed of multiple tissues. The centre of which contains soft, highly specialized, vascular tissue, the marrow, which is surrounded by a dense non-expansile wall, which is invested with a strong fibrous membrane, the periosteum, and at either end of which are the epiphyseal caps separated from the shaft by an avascular wall of cartilage. The second factor is the arrangement of the arteries, which are centripetal in their relation to the flow of blood. The main portion of the circulation to the shaft entering from the periphery by a single vessel immediately divides to be distributed to either end of the medullary cavity. And the remaining entering the diaphysis by the perforating arteries of the periosteum supply the outermost portion of the cortex except at the metaphyses where they perforate the thin cortex to supply its cancellous bone. It is to be remembered that the blood supply to the epiphysis is quite separate from that of the shaft, the conjugal cartilage acting as a wall between the two circulations. Therefore it is seen that the circulation entering the bone flows from its periphery to its centre, and any condition that interrupts its flow at the periphery of the bone will produce an ischemia at its centre.

It has already been stated that the development of acute hæmatogenous osteomyelitis depends upon the presence of virulent bacteria circulating in the blood stream, and a localized point of lowered resistance in a bone where they may be interrupted and held. Consequently, the general resistance of the body must be lowered enough to allow the bacteria, which are present in the blood sufficient time to circulate in its stream to reach a point where they may be interrupted in their passage, and that this point be one of lowered resistance. It has been shown that this point is usually in the metaphysis of a long bone.

The bacteria having been deposited in such a location, grow and multiply, producing a small area of necrosis and liquefaction due to the action of their endotoxins.

If the bone be examined at this time, a small focus of broken-down tissue will be found in the metaphysis, surrounded by zones of leucocytic infiltration and hyperæmia. If near the circumference of the bone, the periosteum over this point will be congested, œdematous and perhaps separated from the cortex by a serous exudate.

Spread of the infection, with death of bone, is the result of interference with the circulation, producing an ischemic necrosis. In a bone in which infection is not present, interference to either the medullary or periosteal circulation alone does not result in death of the bone. For example, removal of periosteum from comparative large surfaces of cortex does not produce a sequestration of the circumferential lamellæ at that point. And in fractures of the shaft of a bone with displacement of the fragments, in which the medullary circulation to the fragment distal to the nutrient foramen is undoubtedly cut off, there is no necrosis, though occasionally some atrophic changes may be seen in the bone structures by a roentgenogram as demonstrated by Bancroft. In the former case where the periosteum is removed,

the outer portion of the cortex probably receives its blood through the anastomosis of its vessels with those from the medulla. While in the latter case, where the entire medullary circulation of one part of the bone is interrupted by the fracture, the circulation to the distal fragment is continued through the connections between the periosteal vessels and those of the medulla. Therefore it is probable that in osteomyelitis, the production of necrosis with sequestra formation is not altogether due to interference with either the periosteal or the medullary circulations alone, but to the embarrassment of both in combination, the result of infection.

Ritter and Wilensky believe that the necrosis is due to the lodgement of an embolus in a vessel. The extent of the necrosis depending upon the size and situation of the vessel plugged by the clot. Wilensky calls this a "thrombo-embolic phenomena," and groups the lesions as follows

"A group of cases of sub-periosteal abscess which are based upon an acute osteomyelitis in the superficial cortex of a bone of slight grade and extent

'A group of cases of acute osteomyelitis in which the main stem of the nutrient artery forms the fixation point and becomes occluded by the thrombo-embolic process and in which as a consequence the entire diaphysis becomes involved in the pathological process, maximum lesions occur. This group is recognized roentgenographically by the sequestration of the entire diaphysis of the bone

"A group of cases of acute osteomyelitis in which one of the primary divisions of the nutrient artery is caught in the thrombus-embolus formation. These are recognized roentgenographically, as well as during operation, when the involvement of the shaft of the bone occurs through the entire thickness of the shaft at one end of the diaphysis, approximately, to one or the other side of the point of entrance of the trunk of the nutrient artery. Such cases are easily recognizable in the X-ray photographs

"A group of cases of acute osteomyelitis in which the thrombus-embolus formation occupies one of the secondary branches of the nutrient artery. These are recognized roentgenographically, and during operation when the involvement of the diaphysis does not extend throughout the thickness of the shaft of the bone. These seemingly follow no rule in their development, are of irregular size and shape, frequently correspond to a thin shell of the cortex of the bone, occupy only a relatively small segment of the circumference of the bone, and depend for their physical characteristics and roentgenographic appearances upon the position of the secondary branch, its importance in the intra-osseous vascular network and upon the possibilities of collateral circulation

"A group of cases of acute osteomyelitis in which the thrombo-embolic lesion is situated in the terminal part of an end vessel of the intra-osseous vascular network. The roentgenological appearances of the finished lesion is that of a cavity in the bone"

This theory of mode of onset is at variance with the etiology and pathology as seen by others. And is not borne out by the clinical and pathological signs as usually found. Besides, as already stated, the stoppage of a vessel of the medullary circulation alone can hardly result in such wide destruction of bone as Wilensky describes, as much blood is received by the bone from the periosteal perforating vessels at the metaphysis. Necrosis of bone may sometimes in severe cases possibly precede the advance of the infection.

The destruction of the periosteal circulation results most frequently from its separation from the surface of the cortex by means of products of inflammation which spread beneath it, having reached there by perforating the

cortex While the medullary circulation embarrassment is possibly the result of an advancing thrombus formation within its vessels

There is some question of how much, if any, intra-medullary pressure is produced by the presence of infection within a bone It seems probable that there must be some increase of the intra-medullary pressure, as even in abscesses in the soft parts, exudates may be found under tension Consequently, within a bone, with its rigid walls, there must be some rise of tension Increase in intra-medullary pressure is usually stated to be accountable for the severe pain and intense constitutional symptoms seen so often in these cases

A point of infection having been established, in a metaphysis, it may spread in one of two directions or in both, that is, it may travel directly out toward the periosteum or into the shaft

However, at times, a point of infection, which has started in a metaphysis, may produce sufficient reaction in its vicinity to prevent a further spread, resulting in a walled-off abscess within the cancellous tissue In time this abscess cavity becomes surrounded by a wall of compact, ebbonated bone which is lined with granulation tissue This condition was first described by Sir Benjamin Brodie in 1830, and is therefore known as a Brodie's abscess Henderson and Simon reported thirteen cases of Brodie's abscess from the Mayo Clinic, and collected reports of other cases from the literature, making 200 in all Of these 200 cases, 69 per cent of the abscesses occurred in the tibia, 10.5 per cent in the femur, 10 per cent in the humerus, 2.5 per cent in the radius, 1 per cent in the ulna and in 7 per cent of the records the site was not mentioned

Of the thirteen cases from the Mayo Clinic, the duration of the disease previous to admission was from five weeks to fourteen years In the eight cases in which cultures from the lesion had been recorded, five were reported sterile and three contained staphylococcus albus Taking into consideration the morphology, duration, and bacteriological findings, it is apparent that a Brodie's abscess represents an early stage of osteomyelitis which has been walled off by the local resistance of the individual's tissues

An infection starting in the metaphysis and spreading toward the periphery of the bone may advance by thrombosing the periosteal perforating vessels Starr believes that it rapidly breaks through into the line between the epiphyseal cartilage and the metaphysis and being limited by the cartilage travels out to beneath the periosteum In most of the cases in which he has shown this to be the route, the original lesion was situated in the metaphysis close to the cortex The infection, having reached the sub-periosteal space, separates the membrane from the surface of the diaphysis, the sub-periosteal space is limited at its ends by the attachments of the osteo-genetic layer to the epiphyseal cartilages In the end of those bones, in which the epiphyseal line is intra-capsular, the periosteum being only composed of one layer (the osteo-genetic), the membrane may be perforated by the exudate and the joint infected

If the infection spreads down into the medullary cavity of the shaft,

which often occurs rapidly, its course is probably by means of the formation of an advancing clot within the medullary vessels. The marrow cavities of the metaphysis being so complicated and their walls so dense it seems hardly possible that the infection reaches the medulla by means of their continuity.

Starr believes that the medulla is most often infected from a sub-periosteal inflammation spreading through the Haversian canals into the cavity of the bone. Possibly this way of extension of the process takes place at times. Recently in two cases with acute osteomyelitis of the tibia, one with the original focus in the upper metaphysis and the other in the lower developed new lesions in the opposite ends of their diaphyses, in both cases the periosteum had been separated by a sub-periosteal abscess for the entire length of the diaphysis. The new lesions were apparently separated from the original foci by normal medullary tissue. In other words there was no demonstrable line of extension within the medullary cavities. Possibly the new lesion developed from the blood.

It is probable that infection seldom, in its early stages, passes from the

FIG. 8.—Specimen of lower end of femur. In the internal condyle there is a perforation from a primary lesion of an acute suppurative osteomyelitis of the epiphysis which produced a suppurative arthritis. Probe is in the opening of perforation.

metaphysis directly to the epiphysis through the cartilage. Hyaline cartilage is quite resistant to acute infections and as there is no communication between the circulation within the metaphysis and that within the epiphysis, the cartilage forms a barrier between these two parts of the bone.

Infection which has reached the sub-periosteal space rapidly separates the membrane from the bone forming a sub-periosteal abscess which continues

to separate more periosteum until drainage is established either by the exudate breaking through the periosteum into the soft parts or by its relief by operation. The separation of the periosteum is preceded by a congestion of its vessels and œdema of its tissues. A complete separation of the periosteum involving the entire surface of the diaphysis will result in a sequestration of the entire diaphysis as the total circulation to that part of the bone has been interrupted at its periphery. If, however, the periosteum be separated from a smaller surface of the bone and the nutrient artery be not damaged, the resulting death of bone may be only the outmost lamellæ of that portion of the cortex from which the periosteal vessels have been removed. A sequestrum of a complete diaphysis occurs but seldom, if ever, as the metaphyses receive much of their blood from the perforating vessels of the periosteum. Usually the line of separation of the shaft takes place just proximal to the metaphyses. Large areas of sequestration take place less commonly in the metaphyses than in the shaft. This is probably due to the fact that the metaphyses are better supplied with blood-vessels than the shaft, that the cortical surface of the metaphysis is greater in proportion than that of the shaft and that the many tendinous attachments on its surface, binds the periosteum more firmly to its surface, preventing widespread separation of the membrane. However, where the periosteum has been stripped from the entire metaphysis and the intra-medullary circulation to it has been cut off, the whole metaphysis may sequestrate. In this case it separates at the epiphyseal line, often leaving the conjugal cartilage intact and undamaged.

The tibia is said to be the bone whose shaft is most frequently sequestered intact. Speed explains this frequency by assuming that the periosteum is not stripped where muscles are attached, for where the periosteum cannot be stripped as in the femur the nutrient artery is not so apt to be destroyed, while in the tibia which has few muscular attachments, the periosteum is easily separated allowing the entire circulation to be cut off.

The destruction of the intra-medullary circulation alone, without involvement of the periosteum, results oftentimes in sequestra formation of the thick cortex of the shaft, but this may not always be the case as frequently sequestra are removed in which the entire medullary cavity has apparently been destroyed, but the dead fragments of bone does not represent the entire circumference of the shaft. From a theoretical standpoint portions of the cortex of the shaft may be kept alive through the collateral circulation derived from the anastomosis between the periosteal vessels and the cortical branches derived from the intra-medullary vessels. Separation of the periosteal vessels and the destruction of the intra-medullary circulation to a given portion of the cortex will always result in death to that part.

The epiphyses are seldom involved, early in the disease, secondarily from lesions of the metaphysis. As already mentioned, when a metaphysis sequestrates the line of separation is through the juxta-epiphyseal region, and such a sequestration does not necessarily destroy the function of growth of the epiphyseal cartilage. Occasionally the epiphyseal cartilage may later be

damaged resulting in a suppression of longitudinal growth in the bone. If the bone with such a lesion is single, the limb in time will be shorter than the other. If the bone involved is paired, valgus or varus deformities will be produced at the joint, in the neighborhood of the destroyed epiphyseal line, as growth ceases in the end of the bone with the damaged epiphysis while the extremity of the companion bone proceeds with its normal growth. Or the healthy bone may become curved, its shaft bowing so as to accommodate its length to that of the diseased bone. In 1912, Martin, presented before the New York Surgical Society, a girl, twenty years of age, in whom there was an arrested development of the radius, resulting from damage to its epiphysis by an osteomyelitis, when she was a year of age.

"The affected forearm was about one-fourth the size of that on the opposite side and was curved to the radial side. The hand on the affected side was about the size of the hand of a child of three or four years.

"An X-ray plate showed that the shaft of the radius was represented by only a small thin portion of bone, the ulna was fairly well developed, but had grown in a curve toward the radial side."

Speed cites several cases of deformities, the result of injury to the epiphysis.

Joints contiguous to bones with lesions of osteomyelitis may be involved either early or late in the period of the disease. Signs of a joint infection are often the first symptoms apparent in cases where an early bone lesion has perforated into the joint, as in a case where the lesion has started in a metaphysis, in which the epiphyseal line is intra-capsular, or in a lesion within an epiphysis. As an example of the former, acute suppurative arthritis of the hip-joint is commonly seen, the lesion causing the arthritis being in the upper end of the femur. This type of case may often be demonstrated by means of a radiograph some weeks after its onset.

Late joint infections are usually due to a secondary involvement of the epiphysis. Starr states that joints are frequently infected during an osteomyelitis through operative procedures.

Occasionally a joint in proximity to a lesion of osteomyelitis in a metaphysis will contain a sterile serum. Such a condition must not be mistaken for one of an early joint involvement. The serum will be absorbed when the bone lesion is properly drained.

When a sub-periosteal abscess perforates the periosteum, it forms an abscess in the surrounding soft parts, separating planes of tissue and may finally point under the skin. A sinus resulting from spontaneous rupture as well as one from incomplete opening is frequently long and tortuous, as the pus in pointing takes the path of least resistance which often carries it along a tissue plane leading well above or below the position of the original focus in the bone.

As in the destructive period of osteomyelitis, the amount of damage to the part is dependent upon the amount of circulation involved in the inflammatory process, in like manner the reparative process is contingent on the

amount of blood supply remaining to the different tissues of the bone after the progress of the infection has ceased

In this latter period the organism must rid itself of destroyed tissues and replace them with healthy ones if the normal function of the part is to be continued

During the constructive period the dead bone is sequestered and the body attempts to remove it, simultaneously it builds up a wall of new bone, the involucrum, by means of the osteo-genetic cells of the periosteum

It is not possible to determine, before complete sequestration has taken place, the amount of bone that has been killed. Cotton states, "Often I have seen what I thought a wholly dead fragment yield only a scale of sequestra, and then go on to do its part in repair." And Bancroft, from experiments and the study of his clinical cases, found that it was impossible in an early stage of an acute osteomyelitis to tell at what point the separation between living and dead bone might take place, and further he came to the conclusion that much of the bone which was apparently destroyed acted as a scaffolding in which new bone is formed. Similar observations have been made in the study of cases on the Children's Surgical Service at Bellevue Hospital, and a further conclusion has been drawn that the presence of a sequestra is important to the part in preventing deformity as it acts as a splint until the formation of a firm involucrum has taken place. Cases in which the sequestrum has been removed at too early a period have resulted in a pathological fracture of the bone.

Pathological fractures through the metaphyses have been seen on several occasions. This apparently occurs soon after the onset of the disease in those cases in which there has been a diffuse involvement of the end of the diaphysis. The metaphysis being made up of cancellous bone, disintegrates rapidly, leaving no long sequestrum to act as a splint until the involucrum is formed. As an example the following case may be mentioned. A boy was admitted to the wards at Bellevue Hospital, with an acute osteomyelitis of the lower end of the femur, the knee-joint became involved. Shortly afterward it was discovered that a supra-condyle fracture had occurred. After reduction recovery was rapid.

Nature removes the sequestra by absorption of the dead bone through phagocytosis and by extruding fragments through the sinuses. The action of the phagocytic cells upon dead bone fragments is well seen in the "moth eaten" or "honey combed" appearance of old sequestra. It seems that the medullary function is the absorption of the sequestrum while the periosteal region has to do with replacing the bone. (Ochsner and Crile.)

The involucrum is formed on the inner surface of the separated periosteum. The function of the osteo-genetic layer of the periosteum commences almost immediately after the membrane has been separated from the bone, but is not in evidence, by the X-ray, until calcium salts have been deposited which takes a period of from three to four weeks.

If the osteo-genetic layer of the periosteum be damaged its function of

producing new bone is lost, and the involucrum at this point is absent. At times shafts of bones which have sequestered are not reformed. Such was the condition in a case of osteomyelitis involving the tibia in which the shaft sequestered with an incomplete formation of an involucrum. It had been



FIG 9—Acute osteomyelitis of the right tibia with destruction of its lower epiphysis. Deformity produced by loss of growth at the lower end of the tibia.

noted at the original operation that the periosteum was gangrenous. It is thought by Dean Lewis that failure in the formation of an involucrum is especially apt when a sub-periosteal abscess has ruptured through the periosteum and has separated it from its surrounding soft parts, thus depriving the membrane of its blood-vessels.

Where the bones are paired, an inflammation of one of them may produce a non-infectious periostitis in the other, resulting in a much thickened cortex. This is most often seen where there has been an osteomyelitis of the tibia involving the shaft, when the fibula may show periosteal proliferation by X-ray.

Where a local focus within a metaphysis has perforated the cortex producing a diffuse separation of the periosteum, new bone may be laid down upon a perfectly normal shaft, irregularly thickening its cortex. At times such a deposit may obscure the texture of the bone to the X-ray. This fact must be borne in mind, when studying a roentgenogram, to discover the extent of the disease within the bone.

At times the growing zone of a bone is stimulated to increased activity. This is evidenced by a lengthening of a limb. This condition has frequently been noted in children who had had a fracture of the femur. In osteomyelitis the same condition may be produced. Recently a little girl was seen, who, three years previously, had suffered from acute osteomyelitis of the left tibia, most of its shaft had been involved. When examined her leg was found to be two centimetres longer than its fellow. Speed has reported several such cases and draws attention to the fact that in the case where there are paired bones, the companion bone is lengthened as

well as the one that had been involved by the infection. He believes that the congestion in the neighborhood of the juxta-epiphyseal region is accountable for the increase of growth.

It has been noted on several occasions that the bones of a limb, one of which had been involved by acute osteomyelitis, failed to grow, its parts being smaller than those of its fellow, and the actual bones, as shown in the X-ray, though perfectly formed were smaller in all proportions than the same bones of the opposite limb. A child, three years old, was seen, who, when a year of age, suffered from acute osteomyelitis of the upper end of the femur. There had been a luxation at the hip-joint, and now the leg and foot of that extremity though perfectly formed are smaller than those of the opposite side. There is three-fourths of an inch difference in the length of the two feet. In Martin's case, which has already been cited, there was an atrophy of the hand. This condition is apparently a trophic atrophy, the inflammation in the limb influencing the conditions governing the growth of the part.

In laying out a plan of treatment, in a case of acute osteomyelitis, one should attempt to visualize the pathology of the case before him. It should be decided first whether the local bone lesion is all that is present or whether it is accompanying a general blood infection. Further whether the infection in the bone is localized or progressing to involve most of the diaphysis, whether the cortex has been perforated forming a sub-periosteal abscess or the infection has spread to involve the neighboring joint, and finally what is the constitutional resistance of the individual to the infection. Some of this knowledge can be discovered from the history of the case, physical examination and immediate laboratory tests, further is obtained at operation and from the individual's reaction following operation together with the report of the findings of the cultures from the lesion and blood stream. This will make up the complete information obtainable at this time, that is until an X-ray examination will be of use.

As may be gathered from the description of the pathology of this disease, the symptoms may vary in intensity from those of an overwhelming septicæmia to those of a well localized bone abscess.

The prognosis is not always dependent upon the intensity of the disease, for many times treatment properly applied, in the form of an early operation, has apparently saved life, shortened convalescence or prevented deformities. The mortality is highest in those patients showing an active bacteriæmia and in the very young.

In any case of acute osteomyelitis the first indication for treatment is the elimination of the focus from which the bacteria are entering the blood stream. In the case of staphylococcus this focus is probably the bone lesion. Where the streptococcus is concerned the lesion is probable in the upper respiratory tract or within the circulation itself. Dean Lewis says

"Streptococci, when introduced into the circulation, seem to use the blood as a culture media—, while staphylococci use the blood as a means of transport."

Therefore it may be impossible to even attempt the elimination of the focus

producing the blood stream infection in certain cases of streptococcus infection. But in the case of the staphylococcus the focus is often demonstrated although its complete elimination can not be brought about at once.

The immediate complete elimination of the infectious lesion, within a bone, is not possible unless such a radical procedure as an amputation of the limb or possibly the resection of the complete diaphysis is performed, and in the latter case infected tissue will probably be left behind. On this basis, not so many years past, complete resection of the diaphysis of a bone in acute osteomyelitis was advised by many surgeons. In but few cases could this have resulted in immediate cure of the infection, and in addition it led to a long post-operative convalescence and frequently marked deformity. In most cases this type of operation was not indicated and much tissue that would have otherwise remained viable was sacrificed. At times complete regeneration of the shaft did not occur. At other times angular deformities and shortening took place in the limb, and occasionally the epiphyseal cartilages were damaged with the resulting loss to the bone of its function of growth.

It was not so long ago that most of us were stripping the bone of its periosteum, removing one side of the cortex over a large part of the diaphysis, and in some cases curetting out the medullary contents, the so called "gutter" operation, thereby depleting the bone of the little circulation left by the infectious process. Amputation, resection of a diaphysis, and curetting the medullary cavities are radical procedures which are followed in most cases by deformities which can be directly ascribed to the operative procedure, and are only mentioned to be condemned. (Amputations are undoubtedly indicated at times to save life, in certain cases of prolonged sepsis.) The deformity of an amputation is evident. Those following a resection of the diaphysis have already been cited. And the permanent sinus leading to a bone cavity or the broad adherent scar, poorly vascularized and frequently breaking down are common sights to us all, a reminder of the "gutter" operation based as it was on a faulty knowledge of the anatomical structure of a bone and the pathology of osteomyelitis.

As far back as 1911, Homans wrote as follows

"I have purposely refrained from discussing at any length the refinements of treatment in complete sub-periosteal resection, because I have been unable to see that the results differ very essentially whichever method is used, though, for reasons which will appear later, I cannot believe that any real advantage of the immediate resection outweighs its danger of failure. This brings me to the matter which seems to me far more important than the resection of totally necrotic bone, a step which, like amputation, is, in a way, a confession of failure. I allude to the treatment of the cases in which the disease has remained local, or in which it has not yet infected the entire medullary cavity. Here the primary operation, the one performed when the surgeon first sees the patient, is of the greatest importance, for it is upon this that the excellence of the ultimate result really depends."

He then states that the early operation has for its object the saving of life and the limitation of infection, and reports two cases in which he had removed a small portion of the cortex and drained, obtaining excellent results.

Cotton in his article, after deploring the fact that there is no "ideal" operation, says in reference to early treatment of acute osteomyelitis, "What one should do, of

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course, is to relieve the local abscess, relieve local tension, avert ischæmic necrosis, save the threatened bone. In other words drain." And later he strongly advises against performing a sequestrectomy until the X-ray shows bony regeneration from the periosteum.

This is sound advice and all that could be added to it is that in the operative technic, care should be taken to obtain the required drainage with as little damage as possible to the remaining blood supply of the bone. As death of the bone, in acute osteomyelitis, is dependent upon ischæmia, produced by the infection, the axiom to follow "ELIMINATE THE INFECTION" should be "IN THE OPERATION DO NOT NEEDLESSLY DESTROY MORE BLOOD SUPPLY." Consequently any operative procedure undertaken should be such that the cavity of the bone is drained with as little destruction as possible to the periosteal and medullary circulations.

The requisites for the successful treatment of acute hæmatogenous osteomyelitis are an early diagnosis, an early operation, sufficient drainage of the infected portion of the bone performed with as little damage to its circulation as possible and properly combating the blood infection.

We all know that frequently patients suffering from acute osteomyelitis are treated for days as acute rheumatic fever. To the medical student and physician it should be taught what are the early symptoms of an osteomyelitis, that the only local sign in the beginning is a point of tenderness over the diaphysis of the bone, and that by the time swelling and redness of the part appears, the infection has usually advanced into the medulla and out under the periosteum. Starr lays particular stress on the fact that pus will generally be found in the bone under the point where the tenderness has been demonstrated. We still frequently hear physicians say that as the X-ray showed a normal bone structure they did not think the case was one of acute osteomyelitis. The roentgenogram will not show inflammatory lesions within a bone until lime salts have been absorbed, producing a rarefaction of the bone, or new bone has been formed by the osteo-genetic layer of the periosteum. This does not take place until two or three weeks after the onset of the disease, and consequently the X-ray is of little or no use in making a diagnosis in the early stage of an acute osteomyelitis.

Operation should be performed as soon as the diagnosis is made. The point of maximum tenderness over the bone should be ascertained before the child is placed under an anæsthetic. The incision should be planned so as to drain directly the infected point within the bone, without damaging important structures overlying it. It should be placed over the point of maximum bony tenderness. The incision in the soft parts should be sufficiently long. The incision into the periosteum should be relatively shorter, and the membrane should, under no circumstance, be stripped from the bone further than it is already separated. The bone should be drilled in several places with a quarter inch bit. If pus is obtained a small trap-door can be opened into the bone with a gouge. Under no circumstances should the contents of the medullary cavity be disturbed. Though pus be found under the periosteum the bone should nevertheless be opened. If on drilling the bone,

pus, under only slight pressure, is obtained without blood, the probabilities are that the medullary circulation at this point is destroyed. If a few drops of pus are evacuated followed by free bleeding the probabilities are that the infection has not produced marked destruction within the bone.

Frequently mistakes are made in diagnosis. Bones have been drilled and no lesion found. The medullary cavity has been opened to find it normal and pus later has been discovered in another part. In such cases the normal tissue exposed at first has not been infected by the pus from the second opening. Starr advises that the drill holes be made as close to the epiphyseal line as possible. Though we have attempted to do this we have found, from experience, that the holes are usually some distance from the cartilage. This has been apparently due to fear of damaging the epiphyseal cartilage.

It has been found that in cases in which the medullary cavity has been involved, that incisions, such as described for early cases, placed at either end of the shaft of the bone will usually successfully drain the infection within the shaft. In these cases, after operation, the temperature will fall and though they may drain for some time there will be no signs of sepsis, unless the opening in the bone becomes obstructed by the contracture of the wound of the soft parts. This condition can be easily overcome by enlarging the opening of the sinus.

Since we have given up the more radical incision, the period of time until healing is complete, in individual cases, has apparently been shortened, the sequestra has been smaller in size, the bone, when finally healed, has shown less sclerosis and there has been a smaller scar and more soft tissue covering the surface of the bone than formerly.

It is impossible to sterilize the medullary cavity by means of the Carrel-Dakin technic, but we have placed Carrel tubes in the wounds of the soft parts as we find that irrigating, with Dakin's solution, liquefies the exudates and allows freer drainage from within the bone.

Where a joint has been involved, early in the disease, it should be drained. The position of the bone lesion, in most cases, is impossible to place and consequently cannot be drained. We have found, however, that in the majority of such cases the drainage of the joint is sufficient.

Placing the limb at rest is of importance. Homans in his article in 1911, lays stress upon this, and recently Orr has emphasized its importance in the treatment of osteomyelitis and infected wounds. The part should be immobilized in proper splints or possibly by suspension with slight traction. The disadvantage of using the circular case is that the wound and surrounding skin cannot be properly cleansed and secondary infections are apt to occur. In addition to the good effects of immobilization on healing, splinting is of importance so as to have the parts in proper position when repair is completed.

It must not be thought that treating the local condition is all that is required. Increasing the general resistance of the individual is of great moment. Rest, fresh air, and proper feeding are necessarily included. Fluids should be forced, when necessary hypodermoclyses should be resorted to, to prevent blood concentration. Multiple blood transfusions have been very

beneficial in combating sepsis and we feel that many of our patients owe their recovery to this form of treatment, especially where there has been an active bacteriæmia. In every case a blood culture should be obtained before or at the time of operation.

It seems needless to say that no attempt should be made to remove sequestra until the X-ray shows a strong involucrum and a complete separation of the necrosed bone. Sequestrectomies should be performed through small incisions, due respect being paid to the blood supply of the diseased bone.

In conclusion emphasis must be laid on the fact that it is the patient, and not the disease, that should be treated. No two cases of acute hæmatogenous osteomyelitis are exactly alike. The disease may vary from that of a well-localized focus to one in which the lesion within the bone is but a part of a general circulatory infection. The intensity of the disease is dependent upon the virulence of the infecting organism in relationship to the resistance of the individual.

As a rule children have strong resisting powers to bacterial invasions, and are not handicapped with organs which have been damaged by the wear and tear of life. Growing tissue has a reparative power greater than that found in mature bodies, consequently deformities in the child stand a better chance of approaching the normal than those in the adult.

When it is all said and done, to obtain the best results, the proper treatment of acute hæmatogenous osteomyelitis is dependent upon a knowledge of the pathology of the disease and sufficient intelligence to apply that knowledge to the case in hand.

From the operative standpoint, it is required to eliminate the point of infection from which organisms and toxic substances are entering the blood, and to prevent further destruction of the bone. This must be done as soon as possible after onset of the disease, and in such a manner that the procedure does not defeat its purpose, by removing further circulation from the bone and thereby adding to the deformity.

The radical operations advised in the past should not be practiced, as simple drainage gives the best result.

STATISTICS OF THIS SERIES

This paper is based upon the study of 138 cases of hæmatogenous osteomyelitis observed in the wards of the Children's Surgical Service, Fourth Division, Bellevue Hospital, during the past six years. All of these patients were under thirteen years of age. Of these 138 cases, the disease was in an acute stage on admission of the patient to the hospital in ninety-eight, and had become chronic in forty. There were eighteen deaths, all in acute cases, a mortality for this type of case of 18 per cent. Of the eighty patients who recovered from the acute stage of their osteomyelitis, seventy-two were followed for periods of a year or longer after their discharge from the hospital in the Return Clinic. Of the forty chronic cases, twenty-six were followed.

Some of these patients were included in the group of seventy-one cases reported in 1925 by Doran and Brown.

FENWICK BEEKMAN

There were three cases in which the epiphysis was primarily involved, two of the lower femur and one of the lower tibia. There were two cases of Brodie's abscess. Tables showing the apparent cause of death, joint involvement and sequelæ follow.

TABLE I
Cause of Death

Case	Sex	Age	Duration of disease before admission	Time in hosp	Part involved	Cause of death	Blood culture
1 G B	F	11 m	3 wks	60 d	Tibia	Pneumonia	
2 P C	M	2 yrs	3 d	14 d	Femur	Pneumonia	
3 M C	M	2 yrs	2 d	2 d	Tibia	Septicæmia	Positive for staphy aureus
4 J C	M	17 m	2 wks	3 d	Tibia	Pneumonia	
5 E D	M	3 yrs	3 d	18 h	Tibia	Septicæmia	Positive for staphy aureus
6 H F	M	5 yrs	1 d	5 d	Tibia Hip-joint	Septicæmia	Positive for staphy aureus
7 S G	F	3½ m	2 wks	12 d	Humerus	Multiple abscesses	
8 J K	M	9 yrs	3 d	1 d	Tibia	Septicæmia	Positive for staphy aureus
9 A H	M	3½ yrs	2 d	4 d	Humerus	Septicæmia	Positive for staphy aureus
10 C L	M	8 yrs	5 d	1 d	Humerus	Septicæmia	
11 L L	F	8 yrs	4 d	2 d	Femur	Septicæmia	Positive for staphy aureus
12 M L	M	5 yrs	3 d	1 d	Femur	Septicæmia Pneumonia	
13 C L	F	2 yrs	1 d	7 d	Humerus	Septicæmia	Positive for staphy aureus
14 C N	M	2 m	7 wks	4 h	Tibia	Not known	
15 C M	M	10 yrs	4 d	62 d	Femur	Septicæmia Suppurative pericarditis Mult abscesses	Positive for staphy hæmolyticus
16 F P	F	9 yrs	7 d	30 d	Humerus	Septicæmia Suppurative pericarditis	Positive for staphy hæmolyticus
17 J P	M	6 yrs	2 d	30 d	Tibia Fibula Mandible	Chronic sepsis	
18 F T	M	9 yrs	5 d	3 d	Tibia	Septicæmia	Positive for staphy aureus

ACUTE HÆMATOGENOUS OSTEOMYELITIS

TABLE II
Suppurative Arthritis from the Primary Bone Involvement

Case	Age	Joint	Infected from	Remarks
<i>Early from Metaphyseal Lesion</i>				
1 N C	17 m	Knee	Femur	Leg now 1½ cm longer than the other
2 J S.	2½ yrs	Knee	Femur	
3 A C	1 yr	Knee	Femur	Leg now 1 cm longer than the other
4 J P	8 yrs	Hip	Femur	Streptococcus
5 J C	17 m	Hip	Femur	Died
6 H F	5 yrs	Hip	Femur	Died
7 E O	11 yrs	Knee	Femur	
8 S M	10 m	Knee	Femur	
9 J M	9 yrs	Knee	Femur	Pathological super-condyle fracture of femur
10 G P	7 yrs	Shoulder	Humerus	
11 R P	1½ yrs	Hip	Femur	
12 S T	1 yr	Knee	Femur	
13 J W	11 yrs	Elbow	Olecranon ulna	
<i>Early from Primary Epiphyseal Lesion</i>				
1 A M	10 yrs	Ankle	Tibia	
2 S S	8 yrs	Knee	Femur	
3 M A	9 yrs	Knee	Femur	
<i>Late from Metaphyseal Lesion</i>				
1 C R	8 yrs	Knee	Tibia	Epiphysis destroyed—shortening of limb—ankylosis of knee
2 R T	6 yrs	Wrist	Radius	
3 C C	5 yrs	Hip	Femur	Ankylosis
4 C L	7 yrs	Knee	Femur	
5 M M	6 yrs	Knee	Femur	Epiphysis destroyed—shortening of limb
6 S O	8 yrs	Hip	Femur	Ankylosis
7 A M	8 yrs	Ankle	Fibula	Ankylosis
8 A N	10 yrs	Knee	Tibia	

TABLE III
Sequelæ Following Acute Osteomyelitis

Type of deformity	Case	Bone involved by osteomyelitis	Remarks
Pathological fracture through metaphysis (5 cases)	W K	Lower femur	Leg now shorter than other
	T G	Lower radius	
	J M	Lower femur	
	G P	Lower tibia	
	E F	Upper tibia	
No regeneration of shaft (4 cases)	E W	Ulna	
	N S	Tibia	
	A D	Tibia	
	R Y	Fibula	
Bowling deformity of shaft (2 cases)	H K	Femur	
	F C	Tibia	
Shortening of limb (4 cases)	W G	Upper humerus	Had suppurative arthritis of knee
	W K	Lower femur	
	C R	Upper tibia	
	M M	Lower femur	
Lengthening of limb (3 cases)	N C	Lower femur	1½ centimetres longer
	D M	Upper tibia	2 centimetres longer
	A C	Lower femur	1 centimetre longer
Atrophic changes of other parts of limb (2 cases)	J S	Upper femur	Bones of leg and foot well formed but atrophied
	C C	Lower femur	Bones of foot well formed but atrophied

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TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD MARCH 5, 1928

The President, DR ASTLEY P C ASHHURST, in the Chair

CALVIN M SMYTH, JR., M D, RECORDER

END RESULTS OF CARPALECTOMY

DR BENJAMIN FRANKLIN BUZBY read a paper with the above title for which see page 266

SUPRA-CONDYLOID FRACTURE OF FEMUR

DR JOHN H JOPSON presented two patients from his service at the Presbyterian Hospital, illustrating the treatment of supra-condyloid fractures of the femur by skeletal traction. In each case the tongs were used, and traction made through the condyles. Both cases were in young men. In one the fracture was a simple supra-condyloid one. In the second the fracture was of the "T" type, involving the joint, with additional comminution of the major fragments, and in very bad position, including lateral and backward rotation of the separated condyles and vertical displacement. A very satisfactory reduction had been obtained in each case by the use of the tongs. An effort is made in these cases to introduce the tong in each condyle at a point above the axial centre, so that the traction may be combined with forward rotation of the lower fragment from the backward position in which it is held by the hamstring muscles. This mechanism has been emphasized and illustrated by Doctor Blake and by Van De Velde of Belgium. The Thomas splint and Pearson attachment of course are used in connection with the tongs, and after the upper end of the lower fragment or fragments of the femur has been rotated into contact with the shaft, the direction of pull on the tongs is raised to straighten the lower fragment into line with the shaft. Doctor Jopson has consistently found the classical position of the fragments in this type of fracture, and believes it due, as usually stated, to the pull of the gastrocnemii. While perhaps many fracture surgeons practice this method of treatment, in which they personally have great confidence, it is curious that it finds little place in the modern authoritative text-books. An attempt had been made in each of these cases presented, to reduce by the Russell method, in which Doctor Jopson has been interested, but it was apparent after a brief trial that it was not effective in this situation and the tongs were then resorted to, as was his usual practice. After removal of the tongs a split plaster case is applied to prevent displacement before the callus is firm, and physiotherapy begun soon thereafter. Both of these cases were still under treatment, and some limitation of joint motion was still present, but motion was improving.

DOCTOR JOPSON spoke of other cases previously reported and treated by tongs traction, including one of supra-condylar fracture complicated by fracture of both bones of the leg on the same side, and one in a child, of anterior displacement of the lower epiphysis of the femur, with fracture of the tibia on that side. Both of these made good recoveries.

DR WILLIAM O'NEILL SHERMAN, of Pittsburgh, said that the treatment by calipers is the method of choice in this particular type of fracture. Ransohoff of Cincinnati used ice tongs some twenty-five years ago. The Pearson pressure pad can often be used to advantage in conjunction with skeletal traction. It must not be assumed that after the tongs have been applied, that the case can be turned over to the interne. Constant readjustment and supervision is necessary. Open reduction where comminution is present is usually contraindicated. Doctor Jopson failed to state how early walking was begun. One great advantage in the use of tongs, is the ability to mobilize at an early date. Most patients can walk with properly fitting Thomas calipers in nine to ten weeks.

DR ASTLEY P. C. ASHHURST said that the patients under his own care with supra-condylar fractures of the femur who had been treated by Buck's extension, did not obtain complete reduction of the deformity, and did not always secure complete flexion of the knee after convalescence. However the patients were satisfied and the surgeon who treated them was satisfied.

DR JOHN H. JOPSON said that concerning Dr Ashhurst's statement that the patients he treated for this type of fracture by Buck's extension were satisfied with the results, it is possible that the patient had never had the method of treatment outlined by Doctor Jopson on the other leg. The speaker changes his ideas on treatment from year to year. He likes to improve on the methods used. At the present time he has in the ward a woman with a fracture of the shaft of the femur who is being treated by the Russell method. She had been in the speaker's service two years ago for fracture of the other femur. When this fact was brought to his attention, Doctor Jopson asked the patient what treatment she had had on her first admission to which she replied "the British method," but that she liked the present treatment, *i e*, the Russell method, better. The British method referred to is the one used by Sir Robert Jones, and consists in the application of Buck's extension and a Thomas splint, and a strapping of the Thomas splint to the frame above the bed and elevating the foot of the bed. Doctor Jopson has used that method successfully in a man who weighed 225 pounds. The speaker thinks if Doctor Ashhurst will give up the Buck's extension and try the tongs extension, he will like it.

As to the length of time which the tongs should be used, the speaker agrees with Doctor Speed that seven weeks is about right. A split plaster case is then applied for two weeks and at the end of nine weeks, this is removed and physiotherapy continued with weight-bearing in eleven to twelve weeks, first with crutches and later without. The use of calipers has not been found necessary.

FRACTURES OF THE OS CALSIS

FRACTURES OF THE OS CALCIS

DR HENRY P BROWN, JR, and DR A A WALKLING (by invitation) presented slides, showing results in cases of fracture of the os calcis which they had followed. These cases were from the services of Dr Charles F Mitchell and Dr John H Gibbon at the Pennsylvania Hospital. The reporters were of the opinion that the results in the treatment of fractures of the os calcis do not compare favorably with those attained in the treatment of other



FIG 1A—Shows typical fissure fracture of os calcis before treatment

fractures, and that the importance of their management is not realized by surgeons in general.

Fractures of the os calcis comprise 2 per cent of all fractures. In the seventy-one cases reviewed, 92 per cent occurred in males whose average age was forty-one, the youngest nine and the oldest eighty. Fifty per cent occurred between the ages of thirty and fifty. The treatment of these fractures, some dating back as far as 1910, was a plaster cast for varying lengths of time, in positions which varied with the type of fracture. The patient went about on crutches and then with a cane for varying periods. Some of these patients still require a cane and are unable to work. The disability ranges from none in certain types to complete in others. It seems that in the avulsion type, expectant treatment is all that is necessary. If there is spur formation with pain, the spur should be removed. The disability here is slight. The types with flattening, shortening or involvement of the subastragalar joint need surgery in some form. Whether it be (1) moulding, (2) excision of callus and remodeling, (3) subastragalar arthrodesis or (4) any combination of these three procedures, depends they think on the type of fracture and disability.

All of their cases, except the avulsion fracture, complained of painful lateral motion, especially eversion. There was marked widening of the os

calcis with excess callus beneath the malleoli, especially the external. There was usually a flat foot. The severely comminuted fracture, with many fracture lines entering the subastragalar joint, might probably do better with moulding combined with subastragalar arthrodesis. The fissured type which involves the subastragalar joint can also be treated in this way.

It seems that the application of tongs or hooks to bring fragments down



FIG 1B—Shows same case after treatment. Subastragalar joint fairly clear. Functional result poor.

is not a good thing. An infection occurring in this already badly contused tissue is apt to be very troublesome. Osteomyelitis of the os calcis is usually quite a serious matter and prolongs hospitalization.

DR FRASER B GURD, of Montreal, said that in all such cases in which it was thought that improvement in the position of the fragments might be obtained, the foot has been hammered into position, the foot is first placed in a pillow splint and the hammering is done on the fifth, sixth or seventh day, never earlier than the fifth day. A full boot of plaster is made with the foot at about a right angle with the ankle-joint and in as marked abduction as can reasonably be secured. The first plaster is applied over a small amount of cotton. The foot of the bed is raised for ten days, then the plaster is removed.

FRACTURES OF THE OS CALSIS

and a second plaster is put on, this time without padding and fitted closely to the upper part of the leg. The patient is urged to walk, if possible without crutches or a stick. Those with a single fracture seem able to walk without a stick or crutch, but the bilateral cases must have crutches as they are not stable.

The patient is allowed to remain in and urged to walk in the plaster or plasters during the ensuing two and one-half to three and one-half months,

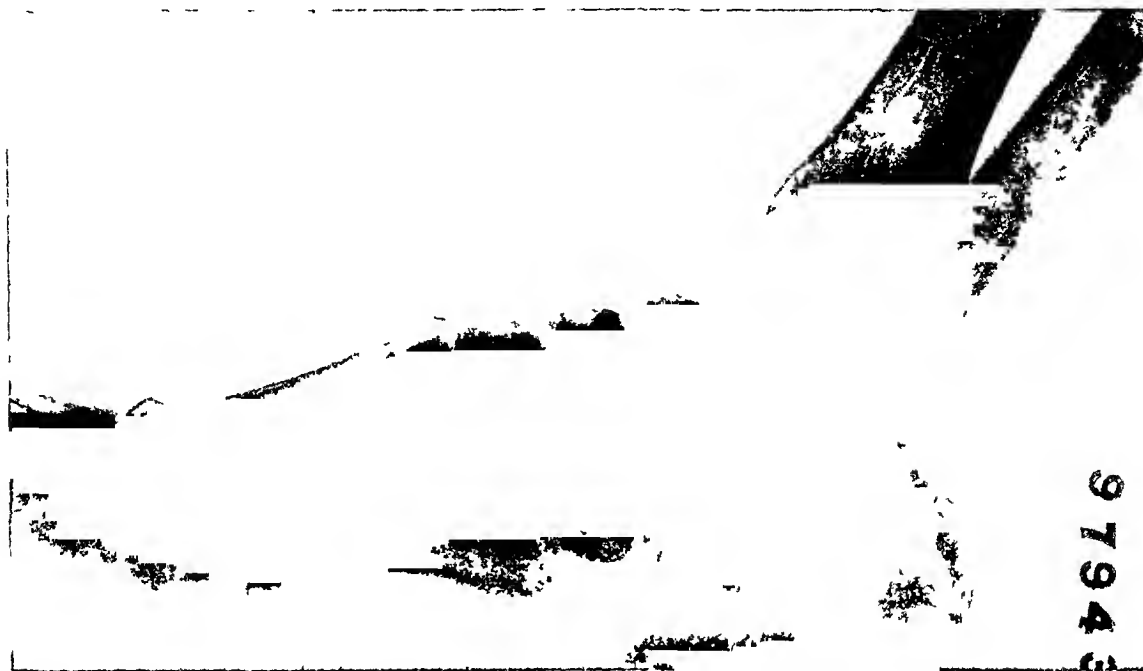


FIG 2A —Shows comminuted fracture of os calcis

the plaster being changed as required owing to the wear and tear causing it to break through. If the hospital facilities permit, Doctor Gurd prefers that the patient should be readmitted for the change of the plaster and for two or three days physiotherapy at the same time. At the end of three or four months the plaster is removed and both sole and heel of the shoe are tilted, raising the inner border one-half inch, and sometimes as much as three-quarters of an inch—so that the patient walks on the lateral border of the foot. During the next two and a half months, the amount of tilt is gradually reduced so that in eight months time, he is walking with one-quarter inch tilt only and is as a rule able at the end of eight or nine months to go back to his work. The patient is advised to continue to wear one-quarter inch tilt for the remainder of his life.

DR NATHANIEL ALLISON, of Boston, said that he did not wish the gentlemen present to think that they have heard the ultimate conclusion in regard to the treatment of fractures of the os calcis, as outlined by Doctor Gurd. Tonight Doctor Gurd used the term "as a rule", this afternoon, he told us 80 per cent of his cases returned to work. The feeling in Boston is that this is not the best treatment for fracture of the os calcis. After having been through all these various methods of treatment, including plaster and hammering, although perhaps not through the tilting of the shoe, Doctor Allison believes that these patients have pain because they injure tremendously the

subastragalar joint and that is why they have disability The thing to do for them is to destroy the subastragalar joint and unite the astragalus and os calcis and hence do away with the pain Of twenty-five cases treated by this method, in only three have good results not been obtained, and in much less time than required by the method described by Doctor Gurd

DR FREDERICK COTTON, of Boston, said that they had heard what hap-



FIG 2B—Shows treatment Subastragalar joint quite clouded Function poor Arthrodesis probably needed for cure

pens without remodeling treatment on a conservative basis, it does not work With skill and attention one can remodel these cases and the speaker has had results with the method described by Doctor Gurd, which were very satisfactory There is a place for conservatism in the use of mechanical treatment Since Doctor Wilson brought out his method of subastragalar arthrodesis, Doctor Cotton has used it—not in the new cases but in the ones which have not done well by other methods

DR CLAY RAY MURRAY, of New York, said that he pursues the method of subastragalar arthrodesis very infrequently, reserving it only for those cases in which there has been marked bone deformity In the majority of cases, he tries to mould the bone back into the original form, as Doctor Cotton has suggested, then to immobilize it in plaster for six to eight weeks with marked inversion of the foot, tilting the foot to the inner side, and following this by

weight-bearing with the insertion under the heel of an ordinary rubber bath sponge with the idea that by this method one eliminates from the weight-bearing the sudden pounding-down on the heel by giving an elastic pad under the heel

DR PHILIP DUNCAN WILSON, of Boston, pointed out that examination of these cases showed that the pain of which they complained was usually a pain felt when they walked on an uneven surface, that anything which caused lateral motion of the foot caused pain. Examination of such a foot showed good ankle motion, but deformity of the heel and limitation of motion in the lateral plane when an attempt was made to invert the foot. The motion was not all gone because there was pain when we attempted to invert, if it had been entirely ankylosed, there would have been no pain. There are other causes of trouble—the possibility of having the foot fixed in inversion—deformity on attempting to throw the heel out—this means that the weight of the body deviates more to the inner side and there is more tendency to turn the foot over. Certain cases have trouble from irregularity of the surface of the plantar bone, but the chief factor is the presence of pain on lateral motion which can be demonstrated by examination and which should be “run to earth.” X-rays have shown it to be a traumatic arthritis of the subastragalar joint, a traumatic arthritis which is evidenced by the fact that there is great tendency to slipping about the joint and thinning of the joint cartilage. That is the reason for doing a subastragalar arthrodesis. As to Doctor Gurd’s method of treatment, the speaker cannot see anything in it which changes the basic factors with which one is dealing. He does not reduce the deformity any more than had previously been done, he only fixes the foot for a little longer period of time, and allows the patient to weight-bear instead of staying in bed. This method will not change the basic condition in these feet. Good results may be due to the fact that under the weight-bearing influence he tends to stimulate ankylosis of the joint. When the X-ray shows severe comminution of the os calcis with involvement of the subastragalar joint and irregularity of the joint surface, it is fair to assume that these patients are going to have pain indefinitely until the joint is returned to the original position or until the joint motion is eliminated.

DR KELLOGG SPEED, of Chicago, called attention to the lack of unanimity concerning treatment of fractures of the os calcis. One enthusiast cuts down on the bone and by narrowing it, takes away the pressure from the external malleolus caused by its thickening. Most men, however, treat these fractures by means of prolonged immobilization with the foot in adduction. Subastragalar arthrodesis is being accepted as the last word in the treatment of the painful feet with prolonged disability in those cases which require compensation adjustment.

DR FRASER B GURD, said that a large proportion of these cases of severe fracture show no movement between the os calcis and the astragalus. Doctor Gurd took exception to Doctor Wilson’s statement that the treatment described by the speaker accomplished nothing more than the older methods. His feel-

ing is that the prolonged walking, following the removal of the plaster and the external tilted position, are of a very great deal of importance in preventing strain of the subastragalar joint. His patients cannot as a rule, abduct the heel, the foot is forever in the position of adduction. It is not the adduction but the abduction which causes pain on walking on irregular surfaces. As the patient cannot abduct, he cannot suffer the pain. *Pain passu* with the continuance of the adduction of the heel there is a tendency for any new bone which may have developed in the neighborhood of the peroneal tuberosity to absorb on account of its freedom from irritation.

COMPOUND FRACTURE OF TIBIA AND FIBULA WITH NON-UNION

DR EDWARD T CROSSAN presented a specimen consisting of the lower two-thirds of the tibia and fibula, with the foot attached. The patient, a man, age twenty-eight years, was originally admitted in October, 1924, to the Episcopal Hospital, in Doctor Ashhurst's service, for fractures of both legs, that of the left being badly comminuted, and with a large wound of the soft parts. The right leg united without deformity, but the fracture of the left tibia remained ununited, one of the large fragments having been removed as a sequestrum before final closure of the wound, which occurred about a year after the injury. The patient wore a brace and walked with crutches for more than three years, when he returned to the hospital (in January, 1928) with evidence of infection at the site of the non-union, the soft parts having been firmly healed for more than two years. Doctor Crossan opened the abscess, finding the ends of the tibia carious, and, at the earnest solicitation of the patient, amputated the leg in February, 1928.

To secure union in the tibia, it would have been necessary to wait until the wound became aseptic, and then insert a bone-transplant. The patient was opposed to any such long delay, and preferred an artificial leg.

The specimen, of which shows bony union of the fibula, without deformity, the site of the second fracture in the fibula can no longer be recognized. The tibia is entirely ununited, its ends showing proliferative and inflammatory changes, with a gap of 15 to 2 cm between them. A steel pin had been passed through the calcaneum, and used for traction for a period of about three weeks at the time of the original injury, the roentgenogram shows this tunnel apparently still open, but in the specimen the outer end of the tunnel is closed, but the medial end is widely open. The incisions in the soft parts had not become infected and had remained healed ever since the removal of the pin.

FRACTURES OF FEMORAL NECK TREATED BY THE WHITMAN METHOD

DR DAMON B PREIFFER related briefly the histories and showed X-ray plates of several cases to serve as a text for remarks concerning the utility of the Whitman abduction treatment for fractures of the neck and trochanteric region of the femur.

One of these cases was unusual in that a woman of eighty having recov-

FRACTURES OF FEMORAL NECK

ered from a fracture of the neck of the femur treated by Whitman's method, fell six months later and sustained an identical fracture on the opposite side. She was again treated in the same manner and good union was secured. It is noteworthy that in this case immediately prior to her first fall her death had been expected almost momentarily owing to the condition of her heart, which was dilated and fibrillating. For the first few days after the accident decompensation was extreme and but slight hope was entertained of recovery. She rallied sufficiently, however, in ten days to permit the application of the case with a few whiffs of ether in order to obtain abduction. Gradually the cardiac condition improved until the heart action became entirely regular and remained so until a fatal attack of cholecystitis five months after the second fracture. It is not too much to say that the immobilization following the fracture saved her life. It is a striking refutation to the idea formerly held that it is unwise to place these aged individuals in a plaster case for fear of circulatory depression. It is an apparent paradox that immobilization of the fracture by these massive cases actually mobilizes the patient, permitting a considerable variety of positions to be achieved by ingenious nursing care. Elevation of the head of the bed, the lateral and the prone positions should be alternated with the dorsal position. These changes, in addition to preventing pressure sores, act as stimulants to the circulation. A suggestive recommendation of this method, as against the older plan of treatment by some form of Buck's extension is to be found in the fact that nurses who have cared for patients under both methods greatly prefer the case, since it makes the patient more comfortable and the nurse's work easier. Of fifteen patients treated in this manner in the last five years there was one death which occurred in a greatly debilitated and arthritic woman over eighty years of age as a result of senile gangrene of the affected extremity. It is not believed that the case was responsible for the gangrene, as this patient was treated for several days without the case on account of her rheumatic contractures and was placed in the case only because of her continued complaint of pain in the leg which in retrospect was apparently due to senile circulatory disturbances, though this was not recognized until after the case had been applied. Functional results have been excellent in about 85 per cent of the cases and good in the remainder.

During this time only one fracture of the hip has been treated without the case. This was a very stout woman of eighty-six years of age with a firmly impacted fracture at the base. The patient eventually recovered and at the present time, two years later, is able to walk with assistance.

It is the reporter's feeling that there are few exceptions to the rule that fractures in this location should be treated in the manner so clearly described by Whitman.

DR CALVIN M. SMYTH, JR., said that he employed the Whitman case in all fractures at the hip including those fractures which were already impacted and in satisfactory position when first seen. In the speaker's experience such patients are much easier to nurse and are more comfortable even though the fracture, in itself, may not require immobilization in abduction. The frequent

change of position, which the case allows is a distinct advantage to the patient with impaired circulation The Whitman case has been employed in two such cases recently with great satisfaction on the part of the patients, the nurses and the surgeon

TREATMENT OF FRACTURES INVOLVING THE ANKLE-JOINT

DR FRASER B GURD, of Montreal, by invitation, read a paper with the above title for which see page 260

UNHAPPY RESULTS IN TREATMENT OF FRACTURES

DR KELLOGG SPEED, of Chicago, spoke on the above topic, using lantern slides to illustrate his remarks The unhappy results mentioned by him were 1 Loss of length of legs 2 Angular deformity, unsightly and disabling 3 Delayed or non-union 4 Infection, osteomyelitis, loss of limb 5 Involvement of blood-vessels, nerves, tendons or muscles causing functional loss Volkman's paralysis 6 Disability in joints 7 Neurasthenical states

Means of Avoiding Unhappy Results—1 Divide all fractures into those of the shaft or those near the joint Their underlying treatment is essentially different Fracture near a joint requires immediate setting, whereas a great many fractures of the shaft require traction and prolonged extension or even operation

2 Inspect and record findings in writing concerning nerves, blood-vessels or muscle injuries When primary injuries are present, operate at once (in 80 per cent at least)

3 Minimize chance of infection

(a) By proper protection of the parts even in closed fracture Every fracture of the leg, the limb should be washed and the skin cleansed with alcohol or some mild antiseptic (b) Immediate primary operation in all open fractures (c) Greater attention to closed methods, thereby reducing the ratio of operative treatment

4 Immediate (permanent) treatment Immediate treatment should merge always into permanent treatment, it should not be given haphazardly (a) Reduce joint fractures completely, and control this by roentgenogram (b) Put shaft fractures in position and splint or use extension traction (c) Check position of fragments by the roentgenogram and if it is unsatisfactory, use skeletal traction

5 Early active motion and massage even in the splint Do not immobilize too long Avoid early weight-bearing or work which might cause secondary deformity Do not let the patient walk too soon on soft callus or use too soon a joint which may be pressed into secondary deformity Active motion and the galvanic current for muscles

6 Increase the blood calcium when delayed union is feared

Sacrifice length of limb if necessary for irritation of the bone ends as by the use of walking calipers or splints to promote bony union Lantern slides of cases were shown illustrating various fracture conditions

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD MARCH 14, 1928

The President, DR FRANK S MATHEWS, in the Chair

ENDOTHELIAL MYELOMA OF THE FEMUR

DR ROBERT H KENNEDY presented a girl fourteen years of age, who was first seen by him February 16, 1927, complaining of pain in the left thigh. Family history negative for cancer. Patient never had any serious illnesses. There was an indefinite history of being kicked on this thigh several years previously. The present illness dated back about two years, the only complaint being intermittent pain in the thigh, becoming steadily more frequent and more severe. Over one year before the pain was so severe that a physician was called. During the previous three months the girl had remained in bed for a day several times on account of the severity of the pain. She had been gaining in weight, but slowly for her age.

Physical examination was negative except for the left thigh. This was 1 cm smaller than the right at various levels. No swelling. No vessels evident. On palpation the femur felt diffusely enlarged in its middle third and was tender. The soft parts seemed movable over the bone. No lymph-nodes were felt. The radiograph showed a rarefaction of the bone from the lesser trochanter to the junction of the middle and lower thirds of the shaft, most marked for about four inches in the middle, with considerable swelling of the shaft at this point. The cortex did not appear to be definitely broken through at any point.

The patient was admitted to the Beekman Street Hospital where an exploratory osteotomy was done four days later. Red blood cells 4,200,000, hæmoglobin 85 per cent, white blood cells 8,800, polymorphonuclears 71 per cent. Wassermann negative. Six urinalyses were negative and no Bence-Jones proteins were found. Radiograph of chest negative for lung involvement. Through an incision on the outer aspect of the thigh it was found that the soft parts were not involved. The periosteum separated readily from the bone, which was slightly roughened and porous. Cortex was thin, and a smooth, soft, vascular mass bulged into the opening as soon as the cortex was removed. After removing specimen the opening was cauterized to stop bleeding and the wound closed. It healed by primary union.

Microscopical examination of sections show for the most part, round or oval spaces (endothelial spaces?), a number of which are empty but most of which are filled with fairly large, round or oval cells with light vesicular cytoplasm and round anaplastic, somewhat irregular-sized and shaped, deeply staining blue nuclei. The cytoplasm of many of the cells and areas where the cells no longer retain their identity, appear to be the site of a myxomatous change. A moderate amount of interstitium is present, much of which is myxomatous.

Pathological diagnosis — Primary endothelioma of bone (Ewing tumor). Further operation was not considered advisable because—

(1) The nature of the lesion. If this was an Ewing's tumor, they are usually multiple early. The only other probability seemed to be a metastasis.

(2) The duration of the lesion With symptoms dating back at least two years it seemed unlikely that there was not some other lesion in the body which had not been demonstrated

(3) The extent of the lesion With involvement up to the lesser trochanter, a disarticulation at the hip-joint would have been necessary and taking (1) and (2) into consideration this did not seem worthwhile She was, therefore, fitted with a Thomas walking caliper splint to guard against fracture of the femur and returned to school

She was subjected to X-ray treatment by Dr Raymond Lewis An attempt was made to keep the tissues saturated with radiation over a considerable period To do this following was given

March 12, 1927 and March 26, 1927 somewhat over a full suberythema dose was given, using anterior and posterior portals April 19 and April 23, half a dose May 27 and June 11, half a dose July 9 and July 18, two-thirds of a dose September 28 and October 6, two-thirds of a dose

A temporary epilation was produced, but no other skin changes

Coley's serum was given steadily up to a dosage of 7 minims The patient was free from pain while in bed and after commencing to use the splint She gained in weight from 99 to 114½ including the splint Radiographs taken at intervals appeared to show some increase in diameter of the bone, but also there appeared to be more calcium laid down within She got about well with her splint, even riding a bicycle

This case was registered with the Committee on Bone Sarcoma as No 801 and the sections reported on by various pathologists Their opinions were about equally divided between Ewing's tumor and a metastatic tumor

The girl was again admitted to Beekman Street Hospital, December 10, 1927, having tripped on a rug the day before, fallen forward and struck the left knee lightly This was followed by immediate pain and swelling The extremity was put up in adhesive plaster traction suspension The radiograph showed a severely comminuted fracture of the left femur involving the shaft for about three inches Radiograph of lung was still negative and no lesions made out in other bones or in abdomen Disarticulation at the hip-joint was therefore advised so that the patient might not be confined to bed

The patient's blood was grouped for transfusion by two technicians as group IV Eight possible donors of this group were cross matched but agglutination of the patient's cells occurred with all The idea of a post-operative transfusion was therefore abandoned Red blood cells 4,000 000 hæmoglobin 80

Operation—December 23, 1927 under 0.10 gm neocaine spinal anæsthesia a disarticulation was done at the left hip-joint The common femoral artery and vein were first tied immediately below Poupart's ligament Wyeth's pins were then passed and a tourniquet placed above these An external racquet incision was used No involvement of the soft parts was seen A cigarette drain was inserted to the acetabulum and another under the distal portion of the stump Patient lost almost no blood but was in moderate shock, which was believed to be partly due to the rather large dosage of spinal anæsthesia for her weight Her condition improved markedly following an intravenous infusion of 750 c.c. normal saline

The patient had a post-operative reaction up to 102.6, twelve hours later, but made a good recovery being discharged on the twenty-first day walking with crutches The wound healed by primary union except for the drain site

Microscopical report same as at the biopsy Her weight was seventy-five pounds on discharge from the hospital and when last seen, February 27 she weighed ninety pounds He had been unable to make out any other lesions

SUPPURATIVE CHONDRITIS OF CHEST WALL

DR CHARLES G DARLINGTON remarked that the greatest part of the existent confusion on the entire subject of bone tumors is largely due to terminology. An exceedingly large number of different names have been given to various tumors, many of which are actually the same tumor, causing a confusion which can be largely remedied if one but follow the classification of the Bone Sarcoma Registry. It must be admitted that confusing terminology is not the only cause of misunderstanding, on this subject, as there still is a world of knowledge, as yet unknown, which will have to be gained before confusion will no longer exist.

The essential features of the tumor reported by Doctor Kennedy are: A primary malignant bone tumor showing characteristic cells, involving the shaft of a long bone, arising in the medulla, comparatively slow growth, growing diffusely, in early stages clinically and roentgenologically resembling osteomyelitis, responding to radiation temporarily, usually found in younger subjects and with a poor prognosis.

Opinions may differ as to whether the lesion is a secondary or a primary one. In favor of it being secondary it is to be noted that

- 1 The alveolar arrangement might suggest an epithelial origin
- 2 This arrangement, with the type of cell with its swollen clear appearance and the peculiar appearance and arrangement of the stroma, might suggest hypernephroma

Against it being secondary but in favor of it being primary, the later sections after the amputation are much more typical than when the biopsy sections were submitted. From these it is to be noted that

- 1 The appearance of the cell, endothelial (?), the nuclei of which are different from those of the hypernephroma cell, and the swollen clear appearance of the cell which in the biopsy slides were thought to contain mucin rather than fat
- 2 The peculiar arrangement of the stroma which would correspond with the stroma of bone marrow
- Further but not last in importance
- 3 The age of the patient
- 4 The diffuse location in the medulla of the shaft, and
- 5 The observation of the patient for over two years with no symptoms of a primary tumor or a secondary growth

As to the ultimate outcome of these cases a definite specific answer is impossible, however temporarily they seem to be favorably influenced by radiation but the general expectancy of life is slightly longer than that in osteogenic sarcoma, which is to quote Kolodny three years as compared with twenty months.

Doctors Ewing, McGuire and McWhorter, and the Registry all cite the same case where radiation, Coley's toxins and amputation were used, in which the patient was well without evidences of recurrence sixteen years after operation. This case however was an adult. There are other cases on record living and well after four years.

SUPPURATIVE CHONDRITIS OF CHEST WALL

DR ROBERT H KENNEDY presented a young girl, who was first seen by him in May, 1925, because of a painful swelling of the lower anterior chest

wall mesial to the right breast. This had been first noticed ten days previously. There was an indefinite recollection of striking against a chair several weeks before. Her past history was irrelevant, except for two severe attacks of pneumonia, the second one six months previously. General health at this time excellent.

The swelling was about 3 cm in diameter, tender, not red nor hot. Skin free over it, but felt attached to deeper parts. Radiograph failed to show any lesion of the chest wall or the lungs. A large number of calcified mediastinal nodes were present. Two weeks later the area was much smaller and less tender.

About two months after the onset, the skin became inflamed and two pin-point openings had appeared, discharging pus. When again seen by the reporter there was an opening, about 1.5 cm across, with ragged bluish edge, filled with exuberant granulations. These were cut away and the pathologist reported granulation tissue. Bare cartilage could be felt with a probe. Radiographs failed to show involvement of costal cartilage or bone. Bismuth injection showed a sinus about 2 cm deep. For the next two months the wound was cleaned and various dressings used until there seemed to be a sequestrum.

October 10, 1925, under local anæsthesia, the tract was excised and the sixth costal cartilage was found involved at the chondro-sternal joint, with the inflammation extending to the adjacent joint above and below. These were rongeuired and curetted away, leaving an opening about 3 cm in diameter, lined by apparently normal cartilage and sternum. The discharge continued as before, cleanliness and various antiseptics, chiefly the chlorines, being used for dressings.

Two months after operation the patient was seen in consultation with Dr. Walton Martin, who advised conservative treatment with carbolic acid and the quartz light. For two months three times a week the wound was scrubbed carefully and carbolic acid was applied. The discharge was somewhat less, granulations not exuberant and bare cartilage in the base of the wound. She received quartz light therapy three times a week during this period. All applications were then stopped, the wound being simply wiped out gently. The quartz light was continued and in one month the wound was healed. Quartz light was continued for three weeks longer.

The wound has now remained healed for two years and she has had no symptoms referable to this region.

DR. ALEXIS V. MOSCHCOWITZ stated that in 1918, in a paper read before the American Surgical Association, he reported a number of cases of suppurative chondritis of infectious nature, and none of these healed until the entire cartilage was removed into osseous tissue.

Only recently, he had occasion to treat a case of typhoid chondritis which had been operated upon a number of times and always healed down to a sinus. The final operation was very extensive, inasmuch as the sixth, seventh, eighth and ninth costal cartilage including the xiphoid appendix had to be removed on both sides. After this, the patient made a prompt and complete recovery.

PEDICLE GRAFT OF KNEE FOLLOWING SYMPATHECTOMY

DR. RALPH COLP presented a boy, twelve years of age, who was admitted to the Beekman Street Hospital, October 23, 1926.

The boy was first admitted to the hospital, September 29, 1925. Four years previous to admission while riding on a moving elevator, his left knee

TUBERCULOUS ULCER OF THE STOMACH

was caught against the wall, and the skin avulsed. At this time he was treated by skin graft, but the wound failed to heal and he was discharged with a persistent prepatellar ulcer.

On his first admission to the hospital, he had a chronic ulcer, surrounded by scar tissue extending over the anterior surface of the knee, both above and below the ulcer for several inches. Under gas and oxygen anæsthesia, the fibrous scar tissue about the wound covering the patella was excised, and with a small drill, six holes were made in the anterior surface of the patella to promote granulations. Parassine dressings were applied. In two weeks' time, the granulations appeared healthy enough to graft but the pinch grafts which were applied did not take. At this time a pedicle graft was suggested, but the patient left the hospital against advice.

Finally, on October 23, 1926, the patient was readmitted for the pedicle graft. The local condition at the time was practically the same.

November 6, 1926, the scar tissue over the patella was removed and several drill holes were again made into the patella. However, after three weeks' time, the granulations were still sluggish, pale and dry, with a sloughing tendency.

November 29, 1926, a Leriche operation was performed in the hope that a periarterial sympathectomy might sterilize the wound. A $3\frac{1}{2}$ -inch incision was made over the femoral vessels, the artery was isolated and its adventitia stripped from Poupert's ligament to the profunda femoris. During this procedure, the vessel did not change in diameter, and no gross change was noted in the color or circulation of the foot.

Within twenty-four hours, however, the granulations appeared healthier, although no other circulatory changes were noted, and within five days the granulations had so improved that a pedicle graft which was formerly impossible, was now practicable.

December 6, 1926, a pedicle graft to the right knee was made by raising a flap from the posterior surface of the right calf, the denuded area being covered with Thiersch grafts. Both legs were encased in a plaster spica.

Two weeks later, the pedicle was severed. The graft was almost completely viable and the Thiersch grafts to the calf had all taken.

January 13, 1927, the patient was discharged with the wound of the knee completely healed except at its upper margin, where there had been a slight skin necrosis.

At present the knee is completely healed, motion is complete, and the patient has been attending school regularly, engaging in ordinary athletic sports. The grafted area on the posterior aspect of right leg looks well and the contour of leg is practically normal.

Leriche, a few years ago, called attention to the fact that following periarterial sympathectomy, chronic ulcerations and slowly granulating wounds often healed unusually rapidly. This case was apparently aided in a dramatic fashion by the femoral sympathectomy. While there is no laboratory proof of the sterilizing value of this procedure in this particular case, clinically a sloughing wound was transformed into one which became clean enough to successfully permit a pedicle graft.

TUBERCULOUS ULCER OF THE STOMACH

DR RALPH COLP presented a negro, fifty-six years of age, who was admitted to the Beekman Street Hospital, February 25, 1927.

In 1921 following an attack of pneumonia the patient vomited a great deal of dark brown material streaked with bright red blood and at the same time he noticed that his stools were tarry. He has not vomited since but has

had yearly attacks of tarry stools lasting four to five days. His last attack began two days prior to admission when he vomited dark brown material and noticed his stools were again tarry. At no time had there been any epigastric pain or distress, or gaseous eructations. His appetite has been fairly good and he has not suffered any recent loss of weight, although at present he feels quite weak.

The past history is negative. He was a rather well developed, poorly nourished, elderly negro, not acutely ill. There was definite evidence of a healed lesion at both lung apices, but no signs of either active or healed pulmonary tuberculosis elsewhere. The abdomen presented no signs except slight abdominal distention.

X-ray examination of the gastrointestinal tract showed a penetrating ulcer of the lesser curvature of the stomach and a definite and persistent deformity of the first portion of the duodenum, which was regarded as diagnostic of ulcer. The stomach, duodenum and most of the jejunum were empty in six hours. Röntgenographs of the chest shows evidence of old healed apical tuberculosis.

The Wassermann examination was negative. The blood count showed 4,200,000 red blood corpuscles, with a hæmoglobin of 72 per cent, and 12,000 white blood cells with 76 per cent of polymorphonuclear leucocytes.

Examination of the urine revealed no abnormality.

Gastric analysis of the fasting content showed free hydrochloric acid, 40. Total, 64. A Refus test-meal: 1st half hour free hydrochloric acid 68. Total 89, 2nd half hour free hydrochloric acid 84. Total 103, 3rd half hour free hydrochloric acid 100. Total 115, with epithelial cells and blood. The sputum at all times was negative for tubercle bacilli.

Feeling that the case was one of gastric and duodenal ulcer, the patient was explored, the operation being started under field block and concluded under gas and oxygen anaesthesia.

About 1½ inches from the cardiac orifice, on the lesser curvature of the stomach, was a hard, indurated ulcer which measured about 1 inch in diameter. The ulcer appeared punched out with overhanging edges. The serosa was thickened in this region and surmounted by three enlarged partially suppurating closely adherent lymph-nodes. The remainder of the stomach was normal except for a scar on the anterior aspect of the first portion of the duodenum, evidently an old ulcer. A typical sub-total gastrectomy was performed closing the stomach and performing a posterior button gastro-enterostomy. The abdomen was closed without drainage.

The pathologist's report disclosed a tuberculous ulcer of the cardiac end of the stomach, with an active tubercular lymphadenitis.

The patient did fairly well following operation with the exception that two weeks later, he developed pain in the left thorax with a friction rub which was soon followed by an effusion. Aspiration of the chest yielded 23 ounces of straw-colored fluid which contained tubercle bacilli. Examination of the lungs, however, clinically and by X-ray, showed no activity at any time.

Since his operation, he has gained forty pounds in weight and has had no recurrence of his gastric symptoms, nor any signs of active tuberculosis elsewhere.

This case is presented as a probable case of solitary tuberculous ulcer of the cardiac region of the stomach. According to Broder's grouping in his paper in the November, 1917, issue of *Surgery, Gynecology and Obstetrics*, it cannot be classified as a positive case because attempts to find the tubercle

EXCISION OF SUBMAXILLARY GLAND

bacilli have been unsuccessful although the histological picture both of the ulcer and the lymph-nodes are quite characteristic of tuberculosis. It is interesting to speculate on the etiology in this case. It conforms partially to the cases of Clayton and Williamson and Chiari reported by Broder in which the tuberculosis was primary in the lymph-nodes at the hilus of the lung, and the retrogastric lymph glands and the stomach were infected secondarily by a blockage of the lymph vessels. In this case before the gastric artery could be ligated proximal to the lesion, the three adherent lymph-nodes had to be sharply dissected away from the base of the ulcer. It appears more than likely that the gastric ulcer was secondary to the tuberculosis of the nodes.

DR CHARLES G DARLINGTON said that the diagnosis of tuberculosis in this case was made on the

- 1 Histopathologic picture of typical epithelioid tubercles, with caseation and giant-cell formation in the submucosa of the stomach beneath the ulcer, and other evidences of tuberculosis such as the typical gross and microscopic tuberculous picture of the lymph-nodes attached to the lesser curvature of the stomach at a point in the wall directly corresponding with the ulcer and
- 2 The absence of any features of syphilis

He was unable to demonstrate the tubercle bacilli in smears or tissue from the stomach or lymph-nodes and while guinea pig inoculations were not made, and the diagnosis was made on the features already mentioned, the subsequent development, by the patient, of a tuberculous effusion in the chest in which tubercle bacilli were demonstrated is strikingly confirmatory evidence.

EXCISION OF SUBMAXILLARY GLAND FOR INFECTION OF THE FLOOR OF THE MOUTH

DR RALPH COLP presented a man, age twenty-seven, who was admitted to the Beekman Street Hospital, June 21, 1927.

Eight days prior to admission, the patient was struck on the right side of the jaw with a baseball bat, causing a fracture of the mandible. He was taken to a hospital, but left the following day. Twenty-four hours after admission his face became so swollen that he could not open the right eye. About the same time he experienced great difficulty in deglutition. When admitted he was acutely ill but fairly well nourished and developed. Cyanosis was marked and the respirations were labored, obstructed and increased in rate. There was a pronounced swelling in the right side of the face. The eye was closed. The right submaxillary region and practically the entire side of the neck was brawny, hard, and œdematous, but not red nor warm. The temperature was 103, and the pulse 120. It was impossible to open the mouth more than about one-half inch, but the tongue was seen to be elevated. The mucous membrane of the floor of the mouth was œdematous. There was marked tenderness at about the middle of the ramus of the right mandible, bony crepitus and malalignment of the teeth. A deep infection of the floor of the mouth was evident. Under local anæsthesia, a five-inch incision, 2 cm below and parallel to the ramus of the jaw was made which was deepened by blunt and sharp dissection, and the submaxillary salivary gland was exposed and extirpated. On section, it was normal. No pus was

encountered until the gland was dissected from its retromaxillary recess. Rubber dam drains and packing were inserted into the retromandibular and mylohyoid spaces.

The patient showed almost immediate improvement after the operation, and within twelve hours was able to swallow with greater ease and open his mouth about one inch. After five days, the packing was removed and the wound irrigated twice a day. Two weeks after operation, he was discharged with a granulating neck wound and referred to a dentist for wiring of the teeth.

The reporter added that in previous communications, the removal of the submaxillary gland has been advocated in deep infections of the submaxillary triangle and in phlegmonous infections of the floor of the mouth. This procedure is not based upon the pathological involvement of the salivary gland for this occurs in less than 50 per cent of the cases, but it is done simply to promote drainage of the retromandibular submaxillary and mylohyoid triangles through the removal of the gland. In this case following a fracture of the mandible, the infection was deep to the salivary gland and drainage was only possible after the gland was removed. A medium suprahyoid incision in this instance would have been without avail.

DR JOHN M. HANFORD questioned the necessity of an incision into the neck in any such abscess so closely beneath the mucous membrane of the floor of the mouth. If this condition was a subperiosteal abscess deeply located beneath the submaxillary salivary gland might not drainage have been established by an incision within the mouth? It was true that not all cases could be so drained. Assuming that there be an abscess deeply located in the submaxillary space, or in its floor, if the gland could so readily be removed, so might it be readily pushed aside by gentle anatomical dissection along tissue planes with maintenance of drainage. This would obviate the necessity for the more extensive dissection in the presence of virulent infection.

DR JOHN A. MCCREERY said that he had seen a considerable number of these cases treated both by excision of the gland and by drainage. He had been impressed by the smoother and more rapid convalescence in the cases in which the gland had been removed, as in those treated by drainage alone the sinus had frequently closed too early and had had to be reopened. There had been occasional objection to the removal of the gland on the ground that this was followed by dryness in the mouth. He had had occasion to see a number of these cases in the follow-up clinic and none of the patients had complained of this condition. He felt very strongly that the removal of the submaxillary gland was by far the most satisfactory method of treatment of this exceedingly serious condition.

PARASINOMA OF THE KNEE

DR JAMES N. WORCESTER presented a man, twenty-seven years of age, who was admitted to Beekman Street Hospital in June, 1927. In 1917, while in the Italian army this man had suffered from "trench rheumatism." At a hospital back of the lines something was injected into knee. This was some kind of oil. Following this he has had a lump on the front of knee which gave

CONSIDERATIONS IN SURGICAL DISEASE OF THE BILIARY TRACT

no trouble until a month ago when he fell on his knee and an ulcer developed

When admitted there was over the anterior surface of the left patella a mass, 2 x 3 inches, projecting above the level of the skin for a distance of one inch. This is reddish-purple in color and in the centre is a deep ulcer with sharp, clean-cut edges. Motion of the knee is practically normal.

This mass is sharply defined and feels like cartilage. Can be slightly moved on patella. Not tender. Wassermann negative.

June 20, 1927, the mass was excised and the skin edges anchored with heavy silk. Twenty-five days later a flap graft from the other calf was done by Doctor Mage. The raw area covered by Thiersch grafts. Pedicle cut ten days later. Later a few Thiersch grafts applied. Patient went home two months later.

Diagnosis. Chronic inflammation about foreign material. Ulceration.

FRACTURE OF FOREARM AND OF BONES OF WRIST

DR JAMES N. WORCESTER presented a man, thirty-one years of age. On July 11, 1927, while playing polo, horse fell, punning the man's left arm underneath it. He was taken to the Greenwich Hospital where a roentgenograph showed fracture of both bones of forearm and of the scaphoid, with a dislocated semilunar. An attempt made under anæsthetic to reduce the fractures was partially successful, as far as the radius and ulna were concerned.

When seen by the reporter seven days after the accident, further X-rays revealed some slipping of radius and ulna and still dislocated scaphoid and semilunar.

At operation, July 19, 1927, the proximal portion of the scaphoid was found dislocated markedly anteriorly and two fragments were entirely loose. The distal portion of the scaphoid was fixed in its socket and also had several small fragments. The semilunar was displaced anteriorly and turned so that its articular surface faced directly forward. Radius showed over-riding of fragments with muscle in between. Through incision over the anterior surface of the scaphoid, the loose fragments were easily removed. Remainder of scaphoid removed with some difficulty. Attempt to replace semilunar was unsuccessful, so it was also easily removed. The anterior ligaments of the wrist-joint were repaired with interrupted sutures and the skin with silkworm and silk.

A second incision was then made over radius, fragments approximated and a Lane Plate with four screws applied. Soft parts closed. Anterior and posterior moulded splints applied reaching below the wrist. These were further shortened so as to give complete motion of the wrist-joint. Active motion to the wrist-joint was started immediately post-operative.

Splints were entirely removed end of four weeks. Active motion in wrist has gradually increased until at the present time the only limitation is a slight one of supination and pronation, which bothers him very slightly.

A large part of the success in this case was the cooperation of the patient for early motion is the one salvation, with or without operation. The cases Doctor Worcester had immobilized have had uniformly bad results.

CLINICAL AND PATHOLOGICAL CONSIDERATIONS IN SURGICAL DISEASE OF THE BILIARY TRACT

DR WALTER A. SHERWOOD read a paper with the above title for which see page 178, ANNALS OF SURGERY, vol lxxxviii.

BRIEF COMMUNICATIONS

CARCINOMA OF THE RECTUM AT EIGHTEEN YEARS OF AGE

THE majority of neoplastic diseases occur between the ages of forty-five and sixty years, especially those tumors involving the large bowel and rectum. The condition occurs rarely in younger individuals. There are cases reported in individuals under twenty years of age. The following case is deemed worthy of report, because of the youth of the patient.

A boy eighteen years of age was admitted to Saint Alexis Hospital in December, 1926, with the following complaint. Since September, 1926, he had had frequent attacks



FIG. 1.—Low power. Section lined by tubular glands, well defined, submucosa and muscle wall diffusely infiltrated with large cell nests undergoing mucoid changes.

of constipation. These attacks were transitory at first, and required no medication. The attacks of constipation became more frequent and lasted longer as time went on. Since November he had been constantly constipated and had resorted to cathartics in order to produce satisfactory bowel movements. Blood and mucus were occasionally found in the stools. During the six or eight weeks prior to his admission to the hospital, he complained of a dull ache in the lower part of the abdomen and in the rectum, this pain was greatly increased on moving the bowels. His first signs of weakness and loss of weight occurred about four weeks before his admission to the hospital. In all he had lost about twenty-five pounds. He complained of no other symptoms. The family history was negative for cancer. There was no history of injury nor of long continued irritation in or about the rectum. He had undergone no operations.

Physical examination revealed a fairly well developed and slightly emaciated male. The general physical examination did not reveal anything remarkable. There were no palpable masses in the abdomen and there was no protrusion from the rectum. On digital examination of the rectum a hard mass was encountered at the tip of the examining finger, this mass encroached upon the bowel to such an extent that the lumen was scarcely larger than a lead pencil. The tumor mass was hard, irregular and moderately fixed. It was painless and about the size of a lemon. It did not bleed readily, as no hemorrhage occurred.

CARCINOMA OF THE RECTUM

even after several examinations. The sphincteric control was not impaired. The spinal fluid examination showed a negative Wassermann. The blood Wassermann was negative.

On December 21, 1926, the boy was operated upon. The abdomen was entered through a lower left rectus incision. The mass was found at the juncture of the rectum and sigmoid. The greatest infiltration had occurred in the posterior wall of the rectum, where the tumor had attached itself to the surrounding tissues. On further examination, the sacral and lumbar glands were found to be involved. Because of this glandular involvement excision of the mass was not attempted. The first stage of a colostomy was then performed. A small section

was removed for microscopic study. Eight radium needles were then inserted into the tumor mass from the anal orifice, and were left in position for eighteen hours. The colostomy was opened four days later with the actual cautery. The eight radium needles were again inserted at a five day interval, and were left in place for twenty-four hours. The report on the specimen was as follows: "A section of the rectum which shows the mucosa and adjacent submucosa to contain numerous glandular elements made up of poorly staining cells undergoing colloid degeneration. These appear in occasional nests and also involving the surrounding deeper structure. Diagnosis, colloid carcinoma of the rectum." The colostomy functioned fairly well during his stay in the hospital. He was removed from the hospital January 1, 1927, much against our wishes. The boy failed rapidly and expired June 22, 1927, six months after admission to the hospital and nine to ten months after his first symptoms had appeared. There was no autopsy.



FIG. 2.—High power. Section of shell nests showing poorly preserved cells which have lost their staining properties and are undergoing marked mucinogenous changes. Diagnosis, Colloid carcinoma of rectum.

The rarity of malignant disease in the rectum of children is readily seen by a review of the literature. One of the earliest cases reported is that of Steiner,¹ who reported a case in a boy nine years of age. Steiner quotes Henig² as saying that the condition occurs about once in 2,000,000 children. The classical and often quoted case of the Allinghams³ was in a boy thirteen years of age. Phillips⁴ a German author collected all cases up to 1908. Warthin⁵ at the University of Michigan found but two cases under thirty years of age in 2,000 specimens. Pennington⁶ in 7174 cases found forty occurring under twenty years of age. Fowler⁷ quoting Mayo Clinic statistics reported

fourteen cases in ten years Clark⁸ late in 1926, reviewed all cases up to that time, and found that there were fifty-one to which he added one of his own

The etiology of cancer occurring in young individuals is just as obscure as that occurring in adults Trauma or long-continued irritation is often given as an etiological factor If such a history can be obtained it will at least serve to draw attention to the affected part, which ordinarily would escape observation The large amount of lymphoid tissue occurring in youth is thought by some to be a cause of adeno-carcinoma

This case is reported through the courtesy of Dr F J Schmoldt Since this report has been prepared a similar case occurring in an eighteen-year-old boy is reported by S A Loewenberg in the *Med Jour and Record*, vol cxxvii, p 183, 1928, New York

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FELIX A SPITTLER, M D,
Cleveland, Ohio

FROM THE SURGICAL SERVICE OF ST ALEXIS HOSPITAL

CONGENITAL ABSENCE OF COLON

THE following report is that of a patient who represents one of the unusual types of colonic abnormalities, in that there was found to be absent the ascending transverse and descending colon, but there was present what appeared to be rudimentary cæcum at the left iliac crest into which the small intestine emptied At the junction of the ileum and rudimentary cæcum the appendix was found

A patient thirty-one years old, was admitted to the Iowa Methodist Episcopal Hospital, complaining of pains in the back and lower left abdominal regions and a continuous pelvic uneasiness and general languor Her appetite was fair, but she suffered from constipation The menstruations were regular but accompanied by a passing of clots and severe pain There was no history of fever or vomiting The examination revealed a marked tenderness over the left iliac region and lower pelvic area Pelvic examination disclosed a tender exaggerated retroverted uterus, seemingly firmly fixed in the abnormal position The fornices were normal

Under ether anæsthesia the abdomen was opened in the midline Since the patient had made special request that her appendix be removed, the cæcum was sought for, but could not be located In fact, no part of the colon could be found, while the retractors were in position and traction was being applied All instruments were removed from the

PENETRATION OF LOCAL SUPERFICIAL FOCI

abdominal incision, and all parts permitted to fall back into their previous position. Then flat retractors were inserted beneath the edges of the incision and the abdominal wall was lifted up, and the appendix, about twice the normal diameter, 10 cm long, was seen standing out rigidly and pointing downward and inward from what seemed to be a rudimentary cæcum which was continuous with the sigmoid, and as accurately as could be measured, it was located about 27 cm above the anus. The terminus of the ileum was easily traced entering the larger gut at the angle of the cæcum and sigmoid.

The chronic inflamed appendix was removed with no difficulty in the usual manner. The retroverted uterus was brought up to the normal position and the round ligaments were shortened by the Baldy-Webster technic. The patient had a normal recovery and the results proved to be very satisfactory.

GEORGE ALFRED FIELD, M D ,
Des Moines, Iowa

PENETRATION OF LOCAL SUPERFICIAL FOCI OF INFECTION BY NEEDLE CARRYING CARBOLIC ACID

ON November 12, 1919, I read before the New York Surgical Society a paper entitled "An Original Method of Treating Boils" and in it described an original technic which I had been practicing for some time in the treatment of boils. In 1925 I read a second paper on this subject before that society. In this method I availed myself of three properties possessed by a 95 per cent solution of carbolic acid: its power of producing local anæsthesia, its power of cauterizing tissue, its power as an antiseptic. The instrument is a needle with the usual blunt eye-end. The eye-end of the needle is dipped in the carbolic acid and gently touched to the focus of the boil. This will deposit a little of the carbolic acid. It may sting for a few seconds. Soon local anæsthesia supervenes. The eye-end of the needle, freshly dipped in the carbolic acid, is then gently pressed upon the tissues with insinuating and searching motions. The needle, eye-end first, will gradually advance through the cutis vera, along a path where the inflammation has made a track of less resistance. If the process is conducted in a leisurely manner, the carbolic acid has time to anæsthetize the tissues in advance of the needle and simultaneously to make the inflamed track yield by progressive cauterization. When a channel has been made through the cutis vera, the blunt end of the needle enters the abscess cavity. The pus now has a vent. By repeatedly dipping the eye-end of the needle in carbolic acid and re-introducing it, the abscess cavity is anæsthetized, cauterized and disinfected. In some cases a single treatment suffices, in others it will require repetition on two or more successive days. There is usually no visible scar. When I have finished with the carbolic acid, I swab the skin or mucosa with alcohol to wash away any carbolic acid from the surface.

When I read my paper in 1919, I had used my method in a large number of cases. Since then I have used it in a very much larger number of cases and for infections in new locations.

Puncture wounds on the sole of the foot made by stepping on up-turned nails I have treated by this technic, either after they had become somewhat inflamed, or at once as a prophylactic measure. The point of entry of the nail

BRIEF COMMUNICATIONS

is touched with carbolic acid. Soon the eye-end of the needle is gently worked in. By using a rather large needle, following the lead of least resistance and proceeding slowly, I have been able, with very little pain, to carbolize the whole track made by the nail and to feel a resistance showing that I had reached the end of the track. This treatment causes very little irritation afterward. The patient may be able to walk in comfort the next day.

I have treated by this method painful stings of bees or yellow-jackets where there was no evidence of infection, but great swelling and pain. In these cases the eye-end of a fine needle armed with carbolic acid was made to follow the sting track through the skin. There was prompt relief. It would seem as if the carbolic acid had destroyed the poison of the sting.

Where a wooden splinter had broken off in the flesh so that it could not be grasped for extraction, I have found that the eye-end of a fine needle armed with carbolic acid would find its way down alongside the fragment of splinter and loosen the tissues by cauterization until the bit of wood could be worked out by the blunt end of the needle.

In an early case of acute paronychia, where there was as yet no indication as to where pus might appear below the skin, I applied carbolic acid at the border of the nail proximally and worked the eye-end of a needle down in it gently for some minutes. The blunt end of the needle advanced and entered a tiny cavity beneath the edge of the nail and a drop of pus exuded. No pus appeared subsequently and in a few days all inflammation was gone.

By a modification of this method, using alternately the eye-end and the point-end of a needle, I have demonstrated that an opening can be made through the sound skin into the subcutaneous tissue with hardly any pain.

I advocate this method as having a very wide application in infections and in some other conditions, giving in most cases where it is applicable quick destruction of infection, very little discomfort to the patient, no incision to heal and usually no perceptible scar.

The judgment of the surgeon will decide in what cases he may use this method and in what cases more radical measures are called for.

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MEETING HELD IN WASHINGTON, D C, APRIL 30, MAY 1, MAY 2, 1928

ADDRESS OF THE PRESIDENT

EARLY HISTORY OF MEDICAL EDUCATION IN CALIFORNIA

BY EMMET RIXFORD, M D

OF SAN FRANCISCO, CALIFORNIA

THE early history of medical education in California is bound up with the lives of three remarkable men—three surgeons—one for many years a Fellow of the American Surgical Association. It partakes of the romance of pioneer days and savors of the gold rush.

The men who braved the dangers and the hardships of the long journey round the Horn, or travelled on horseback or on foot the two thousand miles across the great American desert from the Missouri river to the Pacific, were a hardy lot—weaklings could not keep the pace. These pioneers made a colorful group coming as they did from all walks of life.

Following those who came to dig gold were others who came to prey upon them—gamblers, bandits, thieves—criminals in wide variety. With almost no law but lynch law, men had to stand on their own feet, and individual character speedily came forward and took things into its own hands. But there was much more decency than knavery.

In a country in which stage robbery was almost an honorable profession, the doctor was immune to banditry, because it was tacitly understood that if a stage robber happened to be wounded, the doctor would attend him and not divulge the fact nor the bandit's hiding place to the authorities.

In this heterogeneous company there came a fair sprinkling of fine young men of good family, many just out of college, attracted by the very romance of going to California, some of them trained in the professions of law, medicine and theology. These men left an indelible impression on the community and California owes them an immeasurable debt, for many of them recognized their opportunities for constructive work in the fair new state and remained to "grow up with the country."

In the open places all those who had the slightest knowledge of medicine were called on to help the sick and wounded, malaria particularly and typhoid kept them busy. The man without a diploma who could give a dose of physic or of quinine or iodide of potash held almost as high a position in the com-

munity as did the trained physician. But the physician with a diploma, no matter how easily it had been secured, looked down with scorn on the self-made doctor. It soon became a time of rigid medical ethics, perhaps because hard and fast rules were found to be a necessity when so much in practice was a matter of opinion and precedent instead of knowledge, for bacteria had not yet been discovered and the dissecting room was the only laboratory. Jealousy was fierce and rivalry and competition keen.

Into such a community in 1855 came Dr. Elias Samuel Cooper, scion of a race of strong men of pioneering spirit, implacable as enemies but equally

strong in the making of lasting friendships. An older brother was a physician active in Galesburg, Ill., a younger brother became Professor of Greek and Hebrew in Rutgers College, N. J. It is perhaps evidence of the strength of the Cooper character that all nine children of an older sister (mother of Levi Cooper Lane), had "Cooper" for a middle name.

Born in 1822, in Somerville, Ohio, Cooper began the study of medicine at the age of sixteen in Cincinnati but was graduated in 1840 by St. Louis University—a school which has long since passed out of existence. He began practice in Danville, Ohio, at nineteen



Elias Samuel Cooper

and in 1844 moved to Peoria, Ill. He built the first hospital in Peoria, a three story brick building which was called by the children of the neighborhood "The Spook House." He was all but run out of Peoria because he maintained an anatomical museum and dissecting room above his office, where he worked nights to perfect himself in anatomy that he might be familiar with the anatomical detail of his operative fields. Of course most of the cadavers were surreptitiously obtained. Some supersensitive citizens resented the row of human skeletons which lined the wall and when the County Authorities publicly turned over to Doctor Cooper the bodies of two murderers—victims of the first execution in Knox County, a mass meeting of irate citizens was held but the meeting broke up in a near riot and the matter was quashed.

MEDICAL EDUCATION IN CALIFORNIA

Returning from a trip to Europe he brought with him a quantity of chloroform, and is generally credited with having been the first to use chloroform in anæsthesia in the Mississippi Valley. In 1851, he read a paper before the Illinois State Medical Society, entitled, "The Effect of Chloroform as an Anæsthetic Agent in 79 Surgical Operations." He was vice-president of the society in 1852, president of the Knox County, Ill., Medical Society in 1853.

Doctor Cooper greatly admired Brainerd, founder of Rush Medical College and conceived the ambition of emulating him and founding a medical college on the Pacific Coast. He sailed for Portland, Oregon, but on the steamer met one Captain James M. McDonald who prevailed upon him to leave the ship at San Francisco. I mention "Captain Jim" as we afterward called him, because, out of this friendship for Doctor Cooper and thirty years after Cooper's death, he gave to Cooper College the land on which Lane Hospital stands, as well as a substantial sum in money.

Arriving in California at the age of thirty-three, Cooper was almost immediately active in organizing a state medical society—he was one of those who issued the invitation to the medical profession to assemble for the purpose. He was said by a contemporary to have been the very life of the undertaking. He was an aggressive man who could not be accused of hiding his light under a bushel, for he advertised widely his Ophthalmic and Orthopædic Dispensary in the several score of newspapers of the mining districts. This list of newspapers as revealed by his receipts would be an antiquarian's delight, one, "The Wide West", was published on board an abandoned steamer of that name laid up on the mud in San Francisco harbor. In his dispensary all operations were free to patients presenting themselves on Wednesday and Saturday afternoons and medical men were invited to visit the infirmary on clinic days. These advertising methods were brought up in the Pathological Society and Doctor Cooper was severely criticised by the President. Cooper who was present strode to the chair, shook his fist in the President's face and threatened to thrash him if he uttered another word against him. Dr. A. J. Bowie, a scholar and polished gentleman, a southerner who believed in the code, did his best to arrange a duel, offering the President his services as second so that the insult might be wiped out, but the President's valor oozed out in the drink emporium nearby, whereupon Doctor Bowie changed sides and became a fast friend of Doctor Cooper. Not long after Cooper started his medical school Bowie became Professor of Clinical Medicine.

Cooper* was a fearless surgeon of great originality and with but little education, a demon for work he slept but four hours in the twenty-four. He looked upon surgery as the only field of endeavor worthy of a man. He successfully sutured the fractured olecranon and patella with silver wire, treated refractory club-foot by cutting the soft parts on the contracted side as did Phelps of New York forty years afterward, and, not having plaster-

* Doctor Cooper's contributions were published chiefly in the *Northwestern Medical and Surgical Journal*, 1853, *Pacific Medical and Surgical Journal*, 1858, *California State Journal of Medicine*, 1856-7, *Transactions of the Medical Society of California*, 1858, *San Francisco Medical Press*, which Doctor Cooper founded in 1860.

of-Paris bandages, held the foot in a splint of sheet lead moulded to fit. He advocated early functional demand in fractures and certain diseases of joints devising an apparatus for the leg which he called the "spring boot" which permitted the patient to walk. He announced a new cure for aneurism — cutting down on the tumor and sewing it up from the outside.

Having accidentally torn the iliac vein when ligating the external iliac artery for femoral aneurism, he ligated both vein and artery and observed that the limb retained its warmth. The man recovered with a serviceable leg. Cooper then made a series of experiments on the dog, in some ligating the vein alone, in others the artery and in still others both vessels, and found that the limb remained warmer when both vessels were tied than when only one was ligated. He devised an instrument for the gradual obliteration of the abdominal aorta and used it with some degree of success on the dog. He declaimed against the fallacy of fearing the entrance of "atmosphere" into joints, maintaining that the best treatment of small wounds of joints was to lay the joints wide open and pack with lint. He orated on the fact that his wounds healed better in California than in Illinois, accounting for the difference by the combination of climate with the use of alcohol, for he washed out his wounds with 25 per cent alcohol. He performed the first Cæsarean section in California at a time when the mortality of the mother was 50 per cent of the reported cases. And the woman lived.

The account of the case published in the *Pacific Medical and Surgical Journal* by the editor who had been called in consultation and assisted in the operation, gives such a picture of the surgery of the time that it may not be amiss to digress a bit to quote from it.

The woman was in the thirties, primipara, had been in labor for forty hours, occipito-posterior presentation, the head in sight. Doctor Cooper could not account for the delay except on the assumption of interlocked twins. "After further delay," the editor says, "we operated, he (Doctor Cooper) using the knife, through an incision in the axis of the body between the recti muscles. We found but one fetus, the one which had been in sight twenty hours. It weighed eleven and one-half pounds, enough for two but only one. After various changes and alternations between life and death the patient finally recovered so as to be able to walk in about forty days. The treatment was diaphoretics, aperients, opiates, carminatives, tonics, stimulants, etc., according to symptoms. After the middle of the fourth day she had porter, California wine, bottled soda, eggs, small birds, mutton chops, loin steaks, rice, etc., as much as she desired. The first three days a single thickness of domestic moistened in cold water is applied to the exposed abdomen to get the refrigerating action of evaporation. As soon as suppuration is established this dressing is replaced by a warm poultice of bread and milk until she is well. A weak solution of chloride of soda, (probably chlorinated soda or Labarraque solution) was several times injected through the vagina into the womb from which it issued from the abdominal wound. These cleansings diminished very much the almost gangrenous fetor of the first days of suppuration. The abdominal flatus was drawn off by an œsophagus tube per rectum."

In short the woman recovered. The editor, jealous of Doctor Cooper's reporting the case, wrote a scathing criticism of the error in diagnosis of twins with the result that the most viciously fought malpractice suit of the California courts followed. The editor was the prosecuting witness.

The matter of medical education in California was brought up in the state

society, and at its second meeting, February, 1857, a committee on the subject, Dr John F Morse chairman, reported

"We have no schools in which medical science is being taught nor are there any immediate indications of the practicability of the founding or the sustaining of such institutions. And it is not probable that any elaborate views upon the general relation of the subject will particularly influence those who are now annually engaged in sending out graduates from eastern schools. One thing, however, might be called to the attention of medical educators, viz, the advantages which would arise from a greater professional interest in the acquirement of modern languages. In no country in the world is there such an admixture of languages as in this state and consequently none in which the necessity is so forcibly suggested. A slight knowledge of German, French and Spanish is almost indispensable to the comfort of practitioners. Why men should cling to a system of education which requires years of youthful life devoted to an acquirement of the Hebrew, Greek and Latin languages, the first two of which survive the act of graduation only by some nearly miraculous combination of influences, at the same time that German, French and Spanish are almost utterly neglected, is one of those mysteries which can find no explanation in the common sense of mankind and no apology in any consideration of humanity and social kindness.

"As long as municipal governments regard hospitals as institutions in which the principal object seems to be to show the extent to which a bone-gnawing and washing-saving economy can be inflicted upon the impoverished sick, without any broad demonstrations of murder, so long as popular sentiment requires the managers of these asylums of benevolence to reduce the compensation for medical attendance to a parsimonious pittance, so long as the soul-crushing and heart-withering maxim 'buy cheap and dispense sparingly' is written upon every feature of these institutions, cheap buildings and cheap furniture, cheap bedding and cheap food, cheap physicians and cheap nurses, cheap medicines and cheap instruments, no books and cheap coffins, so long as these are the characteristics that distinguish the popular spirit of American, or perhaps more properly speaking of California philanthropy, so long will it be a useless thing to attempt the establishment of clinical schools of medicine which are the natural and proper nurseries of a complete medical education."

In the very next year, 1858, Cooper started his long projected medical school amid much ridicule on the part of the educated medical public, and which the aforesaid assistant and editor called the "Cooper Shop", and Morse, the writer of the Committee's report just cited, not long afterward joined the faculty. There were well educated and strong men in the group which is said to have met by schedule in Doctor Cooper's office and lectured to each other in default of students. The faculty consisted at first of four doctors and one lawyer, Cooper being Professor of Anatomy and Surgery, R. Beverly Cole, (later President of the American Medical Association) was Professor of Obstetrics and Diseases of Women and Children and Physiology. He was also dean. In his enthusiasm for the new undertaking Doctor Cole urged moving into more elaborate rooms, offering personally to pay the rent. They moved into commodious quarters in Union Hall, Howard Street, San Francisco, over the street car barns, but Cole soon tired of the bargain and the school moved back to its rent free attic.

In default of a charter the school derived its right to issue diplomas from the University of the Pacific, a Methodist institution located at Santa Clara, California and was named the Medical Department of the University of the Pacific. Dr J. Morison, Professor of Principles and Practice of Medicine

and Pathology in the school was a member of the Board of Trustees of the University

In the announcement of the first course of lectures to students which began May 12, 1859, occurs the following remarkable proposal for the course in surgery "First, A regular course of lectures on the principles and practice of surgery, second, demonstrative surgery upon the cadaver, third, experimental surgery by vivisection, in which many of the most important principles are indelibly impressed upon the mind of the student. Members of the class are permitted to assist in these experiments upon animals and afterward expected to repeat them under the eye of the Professor of Surgery. This is an exercise above all others calculated to school the hand, the nerve and the eye of the pupil, and thereby give him the experience he at once requires in performing the duties of an operative surgeon, a feature in medical education, however, almost entirely neglected in many other medical schools."

The course of instruction consisted of five months' lectures repeated in a second year. The fee of each professor was \$20 payable in advance, matriculation fee paid but once, \$5, with graduation fee of \$50.

In 1859, Dr. L. C. Lane joined the faculty as Professor of Physiology, in 1862, Bowie, of the duelling incident, as Professor of Theory and Practice of Medicine.

In 1862, Doctor Cooper died. He was only forty years of age. He was succeeded as Professor of Surgery by Bowie, and in 1863, Henry Gibbons, formerly of Wilmington, Delaware, joined the faculty, taking the chair of Materia Medica and Botany, and J. F. Morse, former editor and publisher of the *California State Journal of Medicine*, accepted the chair of Medicine.

In 1859, the school graduated two students (with ad eundem degree), in 1860, one, in 1861, 5, in 1863, 8, and in 1864, 7, 28 in all.

In 1864, Dr. H. H. Toland founded a new medical school which bore his name. He had erected a commodious building of brick and stone and furnished it at a total cost said by his biographer to have approximated \$100,000. With so imposing a building, the Toland school was launched with great eclat while the old school, lacking the stimulating spirit of Doctor Cooper, was moribund. It ceased its activities and all the students entered Toland and formed a working nucleus for the new school.

The students petitioned the faculty to invite Doctors Lane and Gibbons to join the school. This was done and Lane was appointed Professor of Physiology and Gibbons of Medicine. Dr. Beverly Cole, being persona non grata to Doctor Toland, was not invited.

Dr. Hugh Hughes Toland, born in North Carolina, April 16, 1806, of Scotch-Irish parentage, was a notable figure in Pacific Coast medicine and surgery. Graduating from the Transylvania University of Lexington, Ky., in 1828, he began practice in his native state. In two years he went to France with \$3,000 where he attended lectures and clinics for two and a half years, passing through the cholera epidemic of 1832. Returning to his native state he enjoyed an increasing practice during several years.

MEDICAL EDUCATION IN CALIFORNIA

In 1852, he yielded to the call of the gold fields, shipped out a fully equipped stamp mill, one of the first to reach California, and bought the Gwyn mine in Calaveras County, California. But mining was not for him. He sold out after a year and entered the practice of medicine in San Francisco (1853). He rapidly rose in prominence so that by 1861 his annual income from practice passed the \$40,000 mark, a tidy sum for those days. Without question Doctor Toland received a larger income from his profession than any other practitioner of his day in California and I doubt if anyone has equalled it since.

A striking figure—tall, erect, spare but with large frame, hair falling nearly to his shoulders, upper lip and chin shaved as far as the hyoid—below that a ruff of brown beard which made a wonderful muffler, straight nose, half closed eyes, straight mouth drooping a bit at the corners and massive jaws, he would attract attention anywhere.

He kept office hours in the morning for private patients, in the afternoon for clinic patients. Time and again I have seen his waiting room crowded as in a modern public clinic, often a hundred patients

in an afternoon. No charge was made for the examination of these patients nor for the prescription, but at the end of the corridor next the stairs was Doctor Toland's drug store and none but his pharmacist could decipher the scrawls of that squeaking quill pen. Some idea of the volume of the business done by this drug store could be obtained from a glimpse at the row of scrap books on the top shelf which encircled the room—a veritable frieze of huge books of prescriptions. This drug store was a real gold mine. It is interesting to note too that Doctor Toland did an enormous mail order business. People in the mines of California and Nevada found it easier to write an account of their symptoms to Doctor Toland than to make the long journey by stage to see him. Medicine was forwarded by express, and Wells, Fargo and Company collected the fee. Toland died suddenly, presumably



H. H. Toland

of apoplexy, in 1880, at the age of seventy-four, leaving an estate of nearly two million dollars

Immersed as he was in practice, he had little time for original work, but produced a few clinical papers published chiefly in the *Pacific Medical and Surgical Journal*, and wrote a book on practical surgery

For six years the Toland Medical College waxed strong, but serious differences in policy arose particularly concerning the election of new men to the faculty, and finally culminated in 1870 in the resignation of Lane and Gibbons, who thereupon re-organized the old school. Of the original faculty Bowie and Morse lent their names as professors emeritus, Gibbons was Professor of Medicine, Lane of Surgery, Cole of Diseases of Women and Children. To these were added Edwin Bentley, an ex-army surgeon, as Professor of Anatomy, Clinton Cushing in Obstetrics, Thomas Price in Chemistry. Henry Gibbons, Jr., served as dean and continued in that office for forty years.

All the students but one followed Lane and Gibbons. Toland, left with but one student, moved Heaven and Earth to get the students back, tried to effect a reconciliation, but Lane was not the man to alter a decision once made. Toland even made overtures to Doctor Cole, for the latter was always popular with the students. Not a student budged, but Cole became Professor of Physiology and Dean. He remained with the Toland school and served as dean for many years. This incident was the beginning of a long continued rivalry between the two schools, not always free of bitterness. Lane never forgave Cole.

After an uphill struggle for two years, the Toland school became affiliated with the University of California. Toland stipulated that the medical faculty preserve its autonomy, that he be professor of surgery for life and have the right to nominate his successor. This last condition, however, was not acceptable to the regents of the University. The property was eventually transferred to the University and the school became the Medical Department of the University of California and has remained such till the present day.

The Lane and Gibbons school, having excellent teachers and most of the students, lived by virtue of the quality of its teaching and the sheer force of character of its faculty. Authority for granting degrees was obtained by affiliation with University (City) College so-called, a Presbyterian school founded some sixteen years before and located in the heart of San Francisco, its grounds "forever dedicated to educational purposes" but alas! this block on the southeast corner of Stockton and Geary Streets now carries a great retail department store (The City of Paris). After a time the school took again the old name—Medical College of the Pacific.

In return for the authority to issue diplomas, two students nominated by the Presbyterian Church were to be given free tuition in the medical school each year in preparation for life as missionaries. This arrangement was continued by the medical faculty till about 1895, long after the University

College ceased to exist, in fact some twelve or thirteen years after the school became Cooper Medical College (1882)

In contrast to Cooper and Toland, Lane was a highly educated man. With a better preliminary education, he continued to be a student throughout his long life. Never robust, it was by sheer force of will and self discipline, and by dividing his sleep, that he formed the habit of using six or seven hours in the middle of the night for study. Six nights in the week he read medicine and did his writing, the seventh night he read in general literature. Thus he was widely read, especially in the literature of surgery in the nineteenth century. He was fond of the classics, read Greek and Latin, also French, German, and Spanish. He translated Billroth's Surgical Pathology for his students, laboriously writing it out in long hand in blank books, finishing this or that chapter at three or four in the morning. He read Hippocrates once a year in the Greek.

Levi Cooper Lane, born in Ohio, May 9, 1829 (or 1830), of English Quaker parentage, had some preliminary training at Farmer's College near Cincinnati and later attended Union College, Schenectady, N. Y. This institution later granted him the degree of M. A., and in 1877, LL.D.

He was graduated in medicine from Jefferson in 1851, and spent the following four years as interne and house officer at Ward's Island, N. Y. In 1855, he passed examinations for entrance to the United States Navy, his record remaining as the highest in navy examinations for many years. His thesis on External Urethrotomy was submitted in Latin. For a time he was stationed at the great naval hospital at Quarantine, Staten Island, N. Y., where, he always said, he learned to know typhoid fever. In fact he was himself desperately ill with it. When on sea duty, his ship was stationed on the coast of Central America where he learned Spanish. At Chinandagua, Nicaragua, he performed his first operation for goitre (1858). Incidentally it may be mentioned the ship became the refuge of some of the members of the Walker filibustering expedition in Nicaragua.

Resigning from the Navy in 1859, he joined his uncle Elias Cooper in practice in San Francisco, and at once entered the medical school as Professor of Physiology.

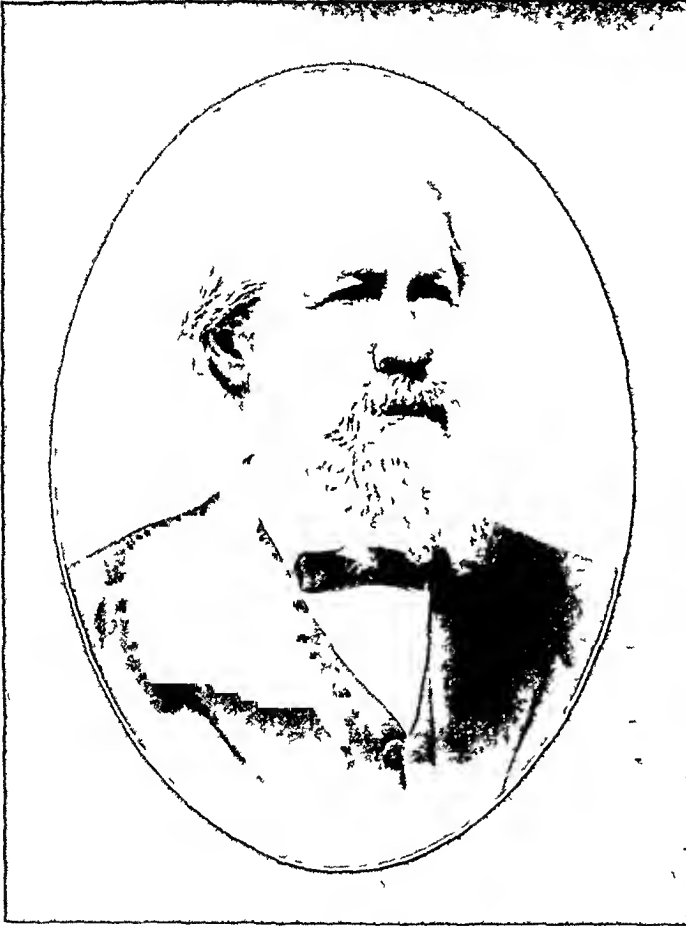
Like most of his contemporaries, Doctor Lane practiced both medicine and surgery. He was possessed of rare good judgment. He was not as original in his surgery as his uncle Elias Cooper, but he worked out vaginal hysterectomy as an original anatomical study (1878), not knowing that the operation had been done in the early years of the nineteenth century in France and had been forgotten. He anticipated Lannelongue in performing craniectomy for microcephaly. He was essentially a student and an organizer. For more than twenty years he had the cream of surgical practice on the Pacific Coast. From Alaska to Chili and from the Pacific to the Rocky Mountains, he drew his patients. He projected an elaborate text-book on surgery in three volumes but lived to finish only the first—"Surgery of the Head and Neck",—a volume unfortunate in form and in the time of

its appearance—it was too late Still it remains a mine of information with an atmosphere possessed by few text-books, of personal opinion based on long experience

In 1882, Doctor Lane unknown to, and therefore without the advice of his faculty, erected a splendid brick building somewhat of the proportions of Rush Medical College, and invited the faculty to join him in re-organizing the school which should thenceforth be named Cooper Medical College in honor of his uncle and in memory of his having founded the first medical school on the Pacific Coast He made one other condition which is peculiarly interest-

ing viz, that there should be given annually in the college a course of public medical lectures

In his announcement of the lectures he said, "In the creation of this course the founder has entertained the hope that besides being a public utility it would tend somewhat to relieve Medicine of the complaint of exclusiveness often charged against it—of neglecting to contribute its quota to the diffusion of knowledge in those departments of science with which medical men are familiar" Again, "A majority of these lectures will be on matters of public health, but some of more scientific character, it is believed, may aid in dispelling the errors popu-



Levi Cooper Lane

larly prevalent that our profession is making no advances, and show to the contrary that no scientist is working more faithfully than the medical, and that in no department of science are more new tracts of knowledge being added than in the medical" In thus breaking away from the hitherto nearly universal attitude of the medical profession that it was the part of the public meekly to take its medicine, Doctor Lane was far ahead of his time He realized that the day of the mystery of medicine was passing, and that the greatest aid to the physician in serving the public was the intelligent cooperation of the informed patient He was hounded, however, in the local medical society and otherwise severely criticised

In 1896 he founded a course of Medical Lectures designed to bring the Profession of the far west into closer contact with the more progressive minds in medical Europe and Eastern America. How well he succeeded is attested by the extraordinary prominence of those who have consented to give these lectures. The brilliant series of lectures of Professor Macewen of Glasgow on the Surgery of the Brain, with which the course was inaugurated, at once impressed the medical world with the seriousness of the undertaking, and made it possible for such men as Sir Michael Foster, Christopher Heath, Sir Thomas Clifford Allbutt, Sir Charles B. Ball, Wm. E. Welch, Reginald Heber Fitz, Vittorio Putti and many others of similar attainment to accept the invitation. As one might easily foresee, the lectures have proved to be of great educational value and a source of inspiration not merely to the students of Cooper College but to the medical profession as well. The lectures are now given biennially.

Doctor Lane built and gave to the college a second building equal in size to the first, and erected Lane Hospital (1894), containing some 150 beds. On a tablet in the vestibule he had inscribed the following: "This building erected by Levi Cooper Lane with moneys earned by himself in his profession, is dedicated to suffering humanity and to the medical profession in the hope that the former may here find refuge and relief and the latter exercise of its humane skill and intelligent sympathy."

Doctor Lane never grasped the technic of antiseptic or aseptic surgery. This he realized for á propos of it he often said "You can't teach an old dog new tricks." Yet he thoroughly believed in the antiseptic idea, *e g*, he was bound that no germ should come into Lane Hospital. Every visitor, doctor and patient on entering was required to put on a pair of clean rubber overshoes. Again, it is pathetic rather than amusing to realize that to keep the operating room pure Doctor Lane bought a barrel of bichloride of mercury and had it incorporated in the plaster on the walls.

Doctor Lane and his faculty had labored unselfishly to build up Cooper Medical College, there was no stock and no dividends, even no salaries until in time laboratory courses were developed. Doctor Lane felt that such devotion as he and his friends had given would serve to keep the institution alive and active for all time, and so in the deeds to the property, he had inserted clauses to the effect that if the college should at any time unite with any other institution the property should revert to the state. But before he died he realized that the cost of medical education must so increase with the development of laboratories that the small endowment thus far secured would be utterly inadequate, and the students could not be expected to pay more than a fraction of the cost of their training. He therefore caused the entire property to be deeded back to him whereupon he re-deeded it to the college without these restrictive clauses. More than that in conversation with Dr. David Starr Jordan, then president of Stanford University, Doctor Lane paved the way for the absorption of the college into Stanford University.

Against much opposition from many sources, perhaps better not men-

tioned here, the amalgamation was effected in 1909. In turning over to Stanford University the college property, including Lane Medical Library, the only conditions made by the directors of Cooper Medical College (who felt themselves trustees of Doctor Lane's memory) were that the property should be used for the purposes of medical education in the sense of teaching young men and young women to be practitioners of medicine, and, second, that Doctor Lane's memory should be suitably preserved. Cooper College Faculty continued till 1912 in order to complete its contract with the matriculants then in the student body.

Doctor Lane died in 1902. His wife, the sole beneficiary under his will, survived him only six months, she left one-third of the estate to the college for a medical library—all she could leave under the law of California to a charity—and the remaining two-thirds to the then president of the college and, be it said to his shame, Professor of Ethics, who accepted the gift and retained it as, to be sure, he had a legal right to do. The two-thirds of the property were then worth a third of a million dollars and have perhaps doubled in value since. I can now imagine Doctor Lane, if he could be conscious of earthly events, censuring me for thus mentioning this matter for it might rescue his false friend from oblivion. I wish I had the power to convey Doctor Lane's conception of oblivion. To him oblivion was wonderful in the completeness of its annihilation!

It is often thought that Doctor Cooper left his nephew a fortune for the medical school. As a matter of fact Doctor Cooper's small estate, some \$30,000, was distributed entirely to relatives in the East, and all that Doctor Lane inherited from this source was a few pieces of furniture, some surgical instruments and a number of belated bills which he personally paid.

Doctor Lane had a sentimental side which was little appreciated but which sometimes took a form that may now seem strange. He carefully preserved in alcohol Doctor Cooper's heart and brain and put them in an inner sanctum in the college where they still remain as a kind of monument to his uncle's ambitions in medical education. Doctor Lane's family inheritance from his mother's estate was but eighty dollars which he used to purchase the pedestal on which Doctor Cooper's heart and brain rest.

Now, after the passing of these picturesque and constructive figures, animosities are dead, the old fights are forgotten and the faculties of the two university medical schools in California have but a friendly rivalry in the effort to do better work for the benefit of the medical profession and for medical science.

But in this change while much has been gained have we not lost something? A colleague put it "Then man was big and science small—now science is big and man is small." That is just it. In our modern educational system are we not becoming swamped in the teaching of the infinite detail of scientific fact perhaps forgetful that the best legacy a college can give its graduates is inspiration for work and thought, and the development of character and sympathy as a motive in the relief of human suffering?

SOME FUNDAMENTAL CHARACTERISTICS OF THE SPLEEN AND THEIR RELATION TO FUNCTION

BY WILLIAM L. ROBINSON, M.B., (TOR.) (BY INVITATION)

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FROM THE DEPARTMENT OF PATHOLOGY, UNIVERSITY OF TORONTO, AND THE TORONTO GENERAL HOSPITAL

A HISTOLOGICAL study of the distended spleen after various injection experiments, seems to indicate that the spleen's chief function is that of filtration. It is essentially a vast spongy network of pulp cells which are reticulo-endothelial in type and function. These cells are surrounded by a capsule and supported by a trabecular framework made up of fibrous, muscle, and elastic tissue. It is capable of considerable variations in size and may hold in its meshes a fair portion of the total blood volume. The trabeculae have firm attachments to the capsule on one hand and to the walls of the veins on the other. This allows, on contraction, for compression of the pulp tissue and distention of the veins. The flow of blood through the spleen appears to be more or less controlled by the relaxations and contractions of the capsule and trabecular framework.

The nature of the blood flow through the spleen is different from that of any other organ in the body. The arterial system is independent of the venous. The terminal arterial capillaries open out and discharge the blood elements into the pulp spaces. In this manner the blood is brought into direct contact with the reticulo-endothelial cells making up the pulp. It is forced from here into the venous sinuses by the contractions of the capsule and trabeculae, gaining entrance to the venous channels through slit-like stomata in their bell-shaped openings at the beginnings of some of the shorter branches. The circulation therefore is an open one. The purpose of this type of circulation is obviously to bring the blood elements into direct contact with the reticulo-endothelial cells in order that they may exercise their known function, namely phagocytosis of foreign elements. Before phagocytosis can occur the foreign particles must adhere to the phagocytic cell. The mechanism by which this occurs represents an interesting problem in filtration. One might describe a filter as something which separates particulate matter from its fluid menstruum. While this may be true the mechanism by which it takes place is not simple. Berkefeld and Chamberlain filters were long thought to filter bacteria because of the smallness of their pores. Beckhold's original formula for determining the mean diameter of the pores would seem to substantiate this view. Using this formula Mudd calculated the mean diameter of the pores of a series of Berkefeld and Chamberlain filters, to vary between 0.38 and 0.45 μ . Bigelow and Bartell, however, have shown an error of one decimal point in this formula, which makes the diameter of the pores ten times larger than that calculated with Beckhold's formula. With the cor-

rection we see that the mean diameter of the pores of Berkefeld and Chamberlain filters varies between 3.8 and 4.5 μ . Pores of this diameter are plenty large enough for the passage of most bacteria. Such being the case there must be some other explanation of this phenomena of filtration. Mudd has suggested and proved that it is dependent upon the electrical charge of the wall of the filter pore. On their walls there is a Helmholtz double layer. Filtration occurs by the process of adsorption of the bacteria to the wall of the filter pore. This occurs when the electrical charge of the bacteria or particulate matter is opposite to that of the wall of the pores. The walls of the Berkefeld and Chamberlain filters, which are made up of siliceous material, carry negative charges and therefore filter out positively charged particles. This theory has been further substantiated by Kramer who made a filter of plaster-of-Paris. The presence of calcium carbonate in the commercial product gave a positive charge to the walls of this filter and with this he was able to filter out colloidal substances which passed through the siliceous filters, and vice versa, substances which readily passed through the plaster-of-Paris filter were held back by the siliceous filters. A series of experiments were done to answer the following questions:

- 1 Is filtration by the spleen mechanical in nature?
- 2 Does it depend upon the vitality of the pulp cells?
- 3 Is it electro-physical as in Berkefeld and plaster-of-Paris filters?
- 4 Is it selective in character?

To eliminate the mechanical factor in the process of filtration the spleen was first distended to capacity with the perfusing fluid. India ink, the particles of which are extremely small as compared with the diameter of the vascular channels and pulp spaces, was added to the perfusing fluid and was readily filtered out by adsorption to the filamentous processes of the pulp cells. Filtration was also found to be independent of the vitality of the pulp cells. Spleens were perfused first with potassium cyanide and later with the India ink solution. Filtration occurred just as readily as in the living specimen. It would seem, therefore, that the process is electro-physical in character, apparently being the same as that of Berkefeld and plaster-of-Paris filters. The question of the selective character of splenic filtration was determined by the perfusion of colloidal metals of known electrical charge. Intravenous injections of colloidal silver, platinum and copper were used for this purpose. The colloidal platinum and silver particles are negatively charged while those of copper are positively charged. It was found that the spleen quite readily filtered out the silver and platinum but the copper passed through, no trace of it could be found adherent to the pulp cells. In the case of the silver and platinum, deposits of these metals could be seen adherent to the filamentous processes of the pulp cells. It would seem, therefore, that the process of filtration by the spleen is electro-physical in character, selective, and not dependent on the vitality of the cell. Substances carrying a negative charge are adsorbed to the pulp cells.

DEVELOPMENT AND PROGRESS OF SURGERY OF THE SPLEEN *

By EDWIN BEER, M D

OF NEW YORK, N Y

IN MANY fields of human pathology, surgery has been privileged to play a decisive rôle, and in the diseases associated with splenic disturbances the recent era has its very basis in the study of our operative results. Most of the diseases of the spleen that are demanding surgical intervention are not as yet reproducible in animals and as a result we are called upon, after due and careful consideration, to adopt a somewhat experimental attitude in approaching many of the problems involved in this new field of therapeutic and nosological research. This newer attitude has given us a much deeper insight into the diseases of the spleen than we ever would have developed if we had followed the older non-surgical methods of approach, and as a result the advance of recent years has been by leaps and bounds compared with the thousands of years of snail-like growth in our knowledge concerning this mysterious organ.

About the physiology and the pathology of the spleen the ancients, Hippocrates and Galen, knew little or nothing, though it is interesting to recall that the former wrote of bleeding from the nose and from the gums in this connection. Galen enshrouded the whole subject in rather unintelligible mystery. He definitely disagreed with those who stated that the spleen was made for no purpose,¹ and suggested that "the residual matters from the liver"² are in part attracted to this organ.³

The following centuries added but little, so that it is not surprising that toward the end of the last century du Bois-Reymond in his lectures on physiology summed up the situation by saying, "Now, we come to the spleen. Of it we know nothing. So much for the spleen." Already at this time the spleen had been attacked by surgeons (for prolapse, hyperplasia, cysts, wandering spleen and malaria), and apparently appeared to be an organ that was not essential to life or to well-being. With the advances in hæmatology, in general pathology, and in organic chemistry, the whole picture has changed so that the recent literature is full of valuable contributions to this subject, which will surely help in clarifying our diagnostic procedures and the indi-

¹ Galen. *Natural Faculties* (Loeb Classical Library) p 143

² *Idem* p 277

³ *Idem* p 213 et seq. Moreover, he believed that "the blood is purified both by the spleen and by the bladder, beside the liver. Also that the humours which are decidedly thick and earthy in nature and have escaped alteration in the liver are drawn by the spleen into itself thus preventing harm to the organism as a whole."

cations for therapy In fact, Herfarth⁴ collected 1,000 papers during 1916-1926 devoted to the subject under consideration, and no one interested in this subject can fail to study and to use his exhaustive and excellent review of their contents Also, at the 1926 International Surgical Congress in Rome, the diseases and the surgery of the spleen were important topics of discussion All of which demonstrates the vital interest taken in the study of this organ which is making for a better comprehension of its physiology and pathology

Since Aschoff and Landau's (1913)⁵ important work on the reticulo-endothelial system there has been a very strong tendency to group the spleen, anatomically and functionally, with the elements of this system, including as it does the Kupffer star-shaped cells of the liver, the medullary tissue of the bones, the lymphatic glands, and the cortex of the adrenal All these tissues contain cells which seem to have a function related to the cells of the spleen, as suggested by their intra vitam carmin staining noted by Ribbert It is very possible, in view of this close relationship, that after the spleen is removed the endothelial apparatus of this system takes over some of the function of the removed organ In other cases splenules or accessory spleens are found, and these after splenectomy may enlarge, just as the remnant of the spleen after resection may enlarge and carry on the function of the spleen In some patients these accessory spleens have been found to be quite numerous, and as many as thirty or forty scattered over the omentum have been reported by Schilling It is interesting to note that these accessory spleens (which may be as large as walnuts) may possibly be the result of intra-uterine or post-birth injuries, because in a number of patients on whom re-operation had been done following a splenectomy for rupture of the spleen, numerous small splenic masses were found scattered, either as milary nodules or as large as cherries, all over the peritoneal surface Albrecht has reported finding 400 such accessory nodules

As far as the physiology of the spleen is concerned, it has been reported by Barcroft and Stephens that this organ changes in shape during exercise, contracting to one-half or one-third its normal size They believe the amount of blood squeezed out is equal to about one-fifth of the blood circulating through the body A similar shrinkage of the spleen has been observed after hemorrhage, perhaps caused by release of stored erythrocytes According to Herfarth's review, the spleen during fetal life contributes to the formation of red blood cells, and under certain conditions in adult life it re-assumes this function In this respect there seems to be a resemblance between the activity of the bone marrow and that of the spleen, both taking part in the production of red cells and myelocytes The spleen, moreover, seems to be the leading organ in the iron metabolism of the body, but just how this iron derived from the breaking down of the red cells is carried from the spleen and formed into

⁴ Herfarth, H *Ergebn d Chir u Orth*, 1926, vol VII

⁵ Aschoff, L *Lectures on Pathology* New York, Paul B Hoeber, Inc, 1924

bile pigments has not been proven, as no free hæmoglobin has been recognized in the splenic vein. It is probably tied in some way to the cells, so that it is difficult to prove its presence. Up-to-date, exogenous iron cannot be differentiated from endogenous iron, as one is liable to cover the other and no discrimination between the two seems possible. Furthermore, the spleen, like the rest of the reticulo-endothelial system, seems to be characteristically active in storing foreign coloring material, as well as body-produced coloring matters. The endothelial cells of this system have also an intimate relationship to the metabolism of lipoids.

The spleen seems to take care of the used up red blood cells, and destroy them. It also deals similarly with the blood platelets. White blood cells are also taken up in the spleen and broken down, and liberate ferments into the circulation. In the spleen, just as in the lymph glands, lymphocytes apparently are produced. In view of the fact that non-operated rats injected with pest cultures (Harris and Bullock) showed a mortality of 22 per cent, whereas of those that were splenectomized 87 per cent died, it would seem that in some way the spleen makes for immunity against infection. It seems proven that bacterial toxins (tetanus, diphtheria), as well as intravenously injected bacteria, are taken up by the spleen and fixed there. It has similarly been claimed that immunity against tumors is probably inherent in splenic tissue, as tumor metastases to the spleen are rather rare, but the evidence along this line in experimental investigation is not convincing.

The most striking changes found in human beings after removal of the spleen, and the changes which interest the surgeon when dealing with system diseases associated with splenic disease, are the blood changes. Following splenectomy there is regularly an increase in the blood platelets, and usually an increase in the red blood cells. Moreover, in view of the fact that some of the red blood cells contain so called Jolly's bodies even as late as twenty years after splenectomy, it is suggested that the spleen may in some way influence the removal of the nucleus from the normoblasts. The blood platelets rise often to well above normal following splenectomy, as do the red blood cells. In fact, cases have been reported where the red blood cells have risen to 13,000,000. As far as white blood cells are concerned, there may be a relative increase in the lymphocytes, as well as in the eosinophile-neutrophiles. As far as resistance to bacterial infection is concerned, there does not seem to be any change following removal of the spleen. It was thought for a time that post-operative temperature and pains in the abdomen were associated with depriving the body of the function of the spleen but although patients have been treated with splenic extract to control this condition on this basis, further study made it clear that the group of symptoms referred to were probably caused by local intraperitoneal conditions either at the ligature of the stump or in the adjacent pancreas, which may have been traumatized during operation.

During recent years, since splenectomy has become a more common procedure, a limited number of students have advocated what Wernert calls

"conservative surgery of the spleen" as opposed to splenectomy. Before the modern era there was considerable opposition to removal of the spleen, even though it had been demonstrated that life was compatible with absence of this organ. It is interesting to note in this connection that the first published operation on the spleen was along the lines suggested by Weinert, namely, ligation of the splenic vessels, by Viard in the 16th Century, who tied the vessels of a prolapsed spleen. In view of the polyglobulie, and in view of the persistence of Jolly's bodies in the red blood cells, A. Weinert⁶ has again forcibly come out for less radical surgery, but up-to-date only a few have followed his line of reasoning (von Stubenrauch, Wendel and Lemaire) and have attempted to control the situation in system diseases by ligating the artery or arteries of the spleen proximal to the left gastric epiploic artery. The reason for this is in part to be found in the fact that ligation of the artery of the spleen may be more difficult than splenectomy. Still, under certain circumstances, where the spleen is very firmly adherent (as in the case reported by Lanz, where it was attached to the urinary bladder) either in an abnormal position or in its normal site, the indications for arterial ligation are self-evident. The only other operation that can be considered in most conditions is total removal of the spleen, though occasionally, in ruptures of the spleen and in localized suppurating processes or localized cystic disease, a resection or incision and drainage may be feasible. In cases of wandering spleen, splenopexy may be indicated.

The operative approach in splenectomy has varied greatly with different surgeons, and no classical incision has been generally accepted. Some surgeons have favored a vertical incision along the outer border of the left rectus, others a transverse incision, others an oblique incision from the costal margin running down toward the navel, and still others a combined vertical and transverse incision. In a few clinics when the operator has decided upon a splenectomy an incision parallel to the left costal margin, starting over the left rectus about one inch from the free border of the ribs and running parallel to the free border of the ribs to the mid-axillary line, has been the method of choice. In case the incision has to be enlarged, the sheath of the rectus, both anteriorly and posteriorly, as well as part of the muscle, can be incised without damaging the muscle, and the incision can be prolonged posteriorly to the posterior axillary line. Although this incision apparently interferes with a number of the intercostal nerves, a weak abdominal wall after primary union is a great rarity. I understand that in Kuttner's clinic this incision is popular, and most of the men at Mount Sinai Hospital use a similar approach. To give ample exposure a sandbag is placed under the left side of the chest, which allows the operator to look well up under the left dome of the diaphragm and see every step of the operation. After the abdomen has been opened and the intestinal coils have been packed off, if the hand is introduced between the spleen and the diaphragm, in simple cases where there are but few adhesions the spleen is readily delivered into the wound, so that the

⁶ Weinert, A. Zentralbl. f. Chir., Dec. 3, 1927, p. 3076

DEVELOPMENT AND PROGRESS OF SURGERY OF THE SPLEEN

short vessels running from the greater curvature of the stomach, as well as the splenic artery and vein, can readily be handled. It is wise, after delivering the organ well into the incision, to place a hot moist pad in the space behind the spleen while the ligation of the vasa brevia is being carried out. It is well to tie these doubly, and cut between before attempting to isolate the larger vessels of the pedicle, which are readily seen and felt through the peritoneal layer which covers them. As one is liable to draw up the tail of the pancreas in this manipulation, one should be careful in ligating the vessels at the hilus, lest one injure the pancreas. It has been my custom to ligate these vessels separately with firm chromic gut, pushing the tail of the pancreas out of the way, as it almost regularly appears drawn up by the vessels which in part run behind the tail of this organ. These vessels can be tied doubly and cut between, or, the proximal ligature being applied, a distal clamp can be used at the splenic hilus. It is somewhat risky to apply a broad pedicle clamp to this pedicle, as one is liable to damage the tail of the pancreas in this way. If adhesions to the diaphragm are found, occasionally they may be reached and tied, at other times one has to pass hæmostatic sutures over these bleeding points to control the bleeding after the spleen is out of the body. Some operators have encountered very large veins in this region, and have recommended approaching these vessels from above the diaphragm. The wound in the abdominal wall should be carefully closed without damage, as drainage not only weakens the wall but predisposes in some cases to the development of subphrenic suppuration.

At times when the diagnosis is doubtful, as in rupture of the spleen, one may be forced to make two incisions in the abdomen, in case one cannot deliver the spleen through the original median or rectus muscle exploratory incision. A non-complicated splenectomy, under these circumstances, can frequently be done through either one of these incisions. In case the spleen is not badly torn it may be possible to suture the organ, underpinning the chromic sutures with fat, muscle or fascia so that they do not cut through the tissue of the organ. In those cases where the splenic artery is to be tied, one must look for this vessel along the upper border of the pancreas after going through the gastrocolic omentum, and ligatures can be applied to the artery as it runs along the upper border of the pancreas or just behind this organ. In the few cases where an attempt has been made to re-attach a wandering spleen, it has been recommended that a pouch be made between the peritoneum and the musculature, so that the lower pole of the spleen can be dislocated into and held in this pouch. Many of these cases, however, do not demand conservation, as the organ is frequently diseased. Even in these cases splenectomy has more often been done than splenopexy. Pre-operative and post-operative transfusions may be of invaluable service in all these operations.

In the report which I made at the International Surgical Congress in Rome, in 1926, of the work done by the staff of the Mount Sinai Hospital along these lines between 1908 and 1926, I was able to report, with Dr. N.

Rosenthal's cooperation, a series of ninety splenectomies⁷ for a great variety of conditions. As many of these cases were operated upon when the indications for surgical procedures were less clear than they are at present, the mortality was unnecessarily high, twenty-eight of the ninety patients dying as a result of the surgical procedure. With more careful selection of cases as years have passed, the mortality has dropped very materially, but even at that time, in a series of fifteen splenectomies for chronic purpura hemorrhagica there were no deaths. During the last two years numerous further splenectomies have been done, with a very moderate mortality.

Instead of dealing with all types of splenic disease in this brief review, it might be advisable to limit myself to a discussion of the more common conditions for which surgery of the spleen has been employed, such as rupture of the spleen, pernicious anemia, purpura hemorrhagica, Gaucher's disease, Banti's disease, and hæmolytic icterus, as these groups illustrate most vividly the progress being made in this field of surgery.

Rupture of the spleen may involve a normal spleen or a diseased organ, and may be traumatic or spontaneous. In traumatic rupture of the normal spleen the bleeding may be so profuse that immediate operation is demanded, and splenectomy becomes a life-saving procedure. On the other hand, in some of these cases the rupture does not lead to such serious results, possibly because the capsule of the spleen is not torn, and after injury a period of well-being follows and secondarily, within a week or so, the capsule of the spleen ruptures and a serious hemorrhage occurs. These cases, sometimes called rup-

7	Total	Well	Im- proved	Unim- proved	P O Exitus	Late Exitus
Floating or ectopic spleen	1	1				
Rupture of spleen	13	11			2	
Tumors of spleen						
a Simple cyst	1	1				
b Echinococcus cyst	2				2	
c Sarcoma	3				3	
d Lymphadenosis	2			1	1	
e Metastatic carcinoma	1				1	
Inflammatory splenitis						
a Tuberculosis	1					1
b Syphilis	1				1	
c Abscess	2	1	1			
Gaucher's disease	5		2		3	
Banti's disease	20	12	1	2	4	1
Hæmolytic icterus	8	5	1		2	
Purpura hemorrhagica						
a Chronic	15	15				
b Acute	2				2	
c Aplastic anemia	3		1		1	1
Pernicious anemia	5			1	3	1
Leukemia	3				2	1
Cirrhosis of liver with splenomegaly	2				1	1
	90	46	6	4	28	6

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ture in two stages are often particularly puzzling to the physician. Cases have been reported where patients have had such an incomplete rupture of the spleen and have become exsanguinated from bleeding out of one of the adjacent viscera, rather than from the spleen. Naturally, exploratory operation is indicated in all of these suspected rupture cases. Recently J. Rhame reported a patient who apparently had a spontaneous rupture of the spleen immediately following his meal. There was no disease of the organ except a recent thrombosis of the veins within the spleen and a certain amount of arteriosclerosis.

Spontaneous and traumatic ruptures of the spleen when the organ is diseased are much more common in tropical countries, where malarial spleens exist, than in our community, though a few cases of spontaneous rupture have been cited during typhoid fever, as in the case reported by Downes. The large spleens of malaria are liable to rupture from slight trauma, and in some countries where malaria is prevalent, as in India and Italy, I understand that it is a criminal offense to strike a man over this region, in view of the danger of rupturing the spleen as a result of an apparently insignificant blow. With the increase in automobile accidents, it is very likely that in coming years we will see an increased number of ruptures of both healthy and diseased spleens, judging from the experience in New York City. If the operation of splenectomy is performed early, the chance of saving life seems to be very good, and in a few cases a suture of the rent may be possible.

Pernicious Anemia—For a number of years medical men and surgeons have been flirting with splenectomy in pernicious anemia, though the results have been far from satisfactory. As the clinical course of this disease seems to vary greatly, and as many patients have remissions, it has been difficult to estimate what splenectomy has accomplished. Kumbhaar⁸ collected 153 splenectomies for pernicious anemia with a mortality of 20 per cent. Of these ninety-nine were apparently benefited. But six months after the operation only fifty-three remained in this group, and after one year only twenty-seven. At the end of two years there were only two survivors, and both of these were still suffering with pernicious anemia. Fortunately, with the advent of the diet suggested by Minot these patients will in future probably be regularly spared this operative procedure.

Purpura Hemorrhagica—Since 1916, this disease has become much better known, and many cases of the chronic as well as the acute type have been referred to the surgeon for splenectomy. The results have been so satisfactory in the chronic cases that the cure of this disease may be considered one of the triumphs of modern splenic surgery. From a review of the literature together with over twenty cases operated upon at Mount Sinai Hospital, I find that many more than 100 patients have been cured by this procedure. Under the impression that the enlarged spleen destroyed blood platelets (which, as is well known, are very much diminished in this disease) Kaznelson, a medical student in Prague, suggested splenectomy. The picture presented by this

⁸ Patel, N. M. VII Congress of International Surgery, 1926, vol. 1, p. 287.

celebrated case, which was operated upon by Professor Schloffer of Prague, is so striking that it is worth while calling to your attention briefly

The patient presented the clinical picture of extreme thrombocytopenic purpura. She was a female of thirty-six and had been under observation for many years for chronic recurring hemorrhages. She had severe epistaxis, petechiæ in the skin, ecchymoses, and had since youth the bleeding tendency. Ten years before the operation she had had severe bleeding from her genitalia, from her nose, from her gums, and general petechiæ. Her hæmoglobin had been as low as 10 per cent, and there was a sudden crisis with improvement, but the epistaxis and petechiæ frequently developed. In 1910, she had severe bleeding after parturition and thereafter had repeated attacks of severe menorrhagia. In 1913, the tendency to bleeding still persisted, and in 1916, the year of admission and operation, there was an uncontrollable epistaxis which dominated the picture. On physical examination her spleen was three fingers' breadth below the ribs, her blood pressure was practically normal, no lymphatic enlargement, no tenderness of the sternum or tibia. Her blood examination showed red blood cells 3,792,000, white blood cells 6710, and the platelets, which were almost exclusively giant forms, numbered 200. Coagulation began in three minutes but there was no clot reaction even at forty-eight hours. The patient's nose was packed for six weeks before the bleeding could be controlled. Petechiæ developed all the time under observation and there was bleeding from the gums. After removal of the spleen, which was a comparatively simple procedure, the change in the clinical picture was most astounding. The bleeding tendency stopped. The platelets rose to 500,000, the bleeding time was shortened, the patient prior to the splenectomy used to bleed from the slightest needle prick, whereas now there was difficulty in getting a specimen on pricking the finger. Moreover, the clot reacted normally. The patient was reported, four weeks after operation, as showing a marked improvement, if not a cure, by splenectomy, of essential purpura hemorrhagica or Werlhof's disease.

The characteristics of this disease, originally described by Werlhof, now usually called thrombocytopenic purpura, are well known, and the remarkable improvement in the picture presented by these patients following splenectomy has probably been noted by every one in this audience. In a recent paper by Dr. Nathan Rosenthal⁹ he calls attention to varieties of purpura associated with thrombocytopenia. The symptomatic thrombocytopenic purpuras associated with leukemia, endocarditis, splenomegaly, Banti's disease, Gaucher's disease, hæmolytic icterus, pernicious anemia, tuberculosis, etc., should naturally be excluded in the diagnosis of essential thrombocytopenic purpuras. In this paper Doctor Rosenthal refers to twenty-two cases of the chronic type cured by splenectomy, and seven more than were included in the above tabulation which was presented at the International Congress. In acute thrombocytopenic purpura operative results are far from satisfactory, as most of the patients succumb^{10, 11, 11a}. Some of these cases may pass into the chronic stage

⁹ Rosenthal, Nathan. *Journal of Laboratory and Clinical Medicine*, January, 1928.

¹⁰ Beer, Edwin. *Essential Thrombocytopenic Purpura-Purpura Hemorrhagica and Its Treatment by Splenectomy*, *ANNALS OF SURGERY*, October, 1926, vol. LXXIV, p. 549.

¹¹ Engel, D. *Arch f klin Chir*, 1924, vol. CXXIX, p. 563.

¹¹ Anschutz. *Zentralbl f Chir*, March 31, 1928, p. 810. Anschutz questions the validity of his assistant, Engel's conclusion as to the inadvisability of splenectomizing the acute cases, as apparently what Engel had interpreted as a primary bone marrow disease was subsequently demonstrated by Schulz to be an artefact. Furthermore, Anschutz states that in two peracute cases in the Kiel Clinic, splenectomy led to cure.

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and others may spontaneously get well (N Rosenthal) while others progress steadily down hill responding but little to therapy

The theory which underlay the original operation of Kaznelson (just described) was that the spleen destroyed the blood platelets and was responsible for their very low number in the circulating medium Frank, on the other hand, thought that while the spleen was in, it exerted an inhibition on the mother cells of the platelets, the so-called megakaryocytes in the bone marrow Brill and Rosenthal, as well as Weinert, thought there might be an influence exerted upon the capillary vessels by disturbed splenic action, perhaps associated with qualitatively changed platelets In the recent publication of Rosenthal just referred to he states that he believes that both the Kaznelson and the Frank factors may play a part in these cases He believes that in those cases where the platelets after splenectomy temporarily increase in number and then drop to low levels again, the condition is due to defective marrow activity (Frank), whereas in those cases where the platelets maintain their increase following splenectomy, the spleen acts as the lytic agent (Kaznelson)

It is interesting that even after splenectomy moderate bleedings occur, or recur, but never to the extent that obtained prior to the operation, despite the fact that only a part of the reticulo-endothelial system has been removed This paradox awaits adequate explanation

In this group of cases X-ray of the spleen, with the hope of shortening the coagulation time, has been tried without much result Stephan and others have become quite enthusiastic about the use of X-ray for this purpose, and they advocated it at the recent International Congress as a pre-operative procedure in all patients liable to have complicated operations associated with excessive bleeding Apparently this has not proven to be a specific action of the Rontgen-rays on the spleen, because others have reported a similar shortening of the coagulation time after exposure of the splenic area following splenectomy Perhaps when the coagulation time is diminished it may be due to action on the blood itself In gynecology, the whole question in cases of menstrual bleeding is being studied on the basis of the hematological situation underlying thrombocytopenia, and it is expected that in view of the fact that this disease is more common in females than in males, these studies will throw light on some of the abnormal menstrual bleedings It is in this group, these purpura hemorrhagica cases, that authors such as Weinert have recommended ligation of the splenic artery, and good results have been reported following this substitute for splenectomy by at least three writers (von Stubenrauch Wendel and Lemaire)

Gaucher's Disease—In this disease splenectomy should probably not be performed I suppose if the diagnosis could regularly be made there would be fewer attempts to perform splenectomy in this disease E P Bernstein¹² was able to make a pre-operative diagnosis of this condition by aspiration of

¹² Bernstein, E P Journal of American Medical Association, 1915, vol lxiv, p 1907

the characteristic splenic tissue. In view of the fact that these aspirations¹² are occasionally followed by serious hemorrhages, the surgeon has been hesitant in taking such diagnostic steps. Apparently Gaucher's disease is a system disease, and removal of the spleen eliminates only one element, the rest of the reticulo-endothelial system being in the same condition, or in a similar condition, to that of the spleen. Whether this is a metabolic disturbance, as suggested by Aschoff, or whether this is a system proliferation approaching neoplasia, has not been settled, but in view of the fact that the spleen is only a part of the disease, the operation of splenectomy seems of questionable propriety. In the last case operated upon by me, the spleen was removed under the impression that we were dealing with Banti's disease, and the gross and microscopic appearance was that of Gaucher's disease. Though the patient recovered and is greatly improved in general health, having gained many pounds, it is questionable whether any permanent relief has been obtained.

Banti's disease, or chronic splenic anemia, is still one of the moot questions both in nosology and therapy. Although many people believe that such an entity as Banti's disease exists, a primary splenomegaly with secondary cirrhosis of the liver developing into a third stage with ascites, others are very skeptical concerning its clinical entity. Whether the more refined blood examinations recently published by Rosenthal are going to help in the establishment of the clinical picture of this disease, as well as the prognosis following splenectomy, remains to be seen.¹³ That there is a clinical picture of enlarged spleen which shows Banti's disease (originally described as "fibroadenie") associated with leukopenia and anemia and clinically manifesting itself in hemorrhages from the alimentary tract, and going on to a cirrhosis of the liver with ascites, cannot be denied. Whether this is a primary disease of the spleen which secondarily affects the liver, is difficult to demonstrate.

Judging from the literature, typical cases of Banti's disease are more common in Italy than in the more northern climes. Splenectomy, in this group of cases, seems to have a very definite beneficial effect, even though all the manifestations of the disease are not permanently eliminated. Hemorrhages from the alimentary tract (even fatal ones) occur months or years after splenectomy. Lecene¹⁴ only recently reported such a case in which a fatal gastric hemorrhage occurred six months after splenectomy, and one case which I presented before the New York Surgical Society¹⁵ had a very severe gastro-intestinal hemorrhage several years after removal of the spleen in the ascitic stage of this disease. At the International Surgical Congress, Schoemaker made what is perhaps an important contribution to this subject of obscure hemorrhage from the bowel, when he reported successful control

¹² Diagnostic aspirations of the bone marrow have also proved of great diagnostic value.

¹³ Rosenthal, Nathan. Studies on Banti's Disease. Blood Platelet Factor With Reference to Splenectomy. Jour Am Med Assn, 1925, vol 144, p 1887.

¹⁴ Lecene, P. Zentralbl f Chir, 1928, p 38.

¹⁵ Beer, Edwin. Banti's Disease. ANNALS OF SURGERY, 1920, vol 141, p 216.

of some of these severe hemorrhages by splenectomy where other procedures such as resection of the bowel or of the colon, or of the colon-cæcum, had been of no avail the removed intestine and other examinations of the alimentary tract having been negative.

In reviewing the results of splenectomy in his disease some years ago, Banti claimed that splenectomy cured this condition permanently provided the operation was done early and he reported cases that remained well for fifteen years. According to Banti, the operation should be done in the first and second stages only but cases have been reported where even in the face of ascites beneficial results have followed splenectomy. Talma's operation done at the same time as the removal of the spleen, may deserve some slight credit for the beneficial effect.

From the careful blood studies made by Rosenthal¹³ it would seem that splenectomy in Banti's syndrome gives the best results in the thrombocytopenic group. In those cases, on the other hand, where before splenectomy the platelets are normal or somewhat subnormal and rapidly "increase to enormous numbers" after operation and remain high, the results are not as satisfactory. Thromboses and hemorrhages disturb the picture.

Hemolytic Icterus or acholuric icterus is another system disease in which splenectomy has gradually gained recognition as apparently no other therapy has to date proven of value. This disease occurs in two types, the original familial type being first recognized only the beginning of this century by Minkowski and the acquired type was first noted by Hayem. Whether the underlying condition is due to an inflammatory disturbance in the spleen or not has never been clarified. Repeatedly cases have been described running through several generations of a family and the clinical picture in both this type and the acquired type is very much alike. Whatever the cause of the original disturbance the spleen seems to interfere with the normal existence of the red blood cells and as a result the patients gradually develop a yellowish discoloration of the skin and sclera. The disease is very chronic in its course though following exposure or other infections the icterus becomes more marked and febrile attacks develop.

The most striking symptoms, as is well known, are enlargement of the spleen, icterus, increased fragility of the red cells with anemia, the presence of urobilin and the absence of bile in the urine, and a positive indirect Vandenberg reaction. In some patients pains simulating gallstone attacks have been noted, and others have developed, as a result of inflammatory reaction around the spleen, pains in this region as well. In the mild cases, where anemia, pain and icterus are slight, it is questionable whether such a serious procedure as splenectomy should be attempted, even though it is to date the only curative method of dealing with this disease.

The operative treatment by splenectomy has become so well recognized within the last few years that some clinics have already reported many dozens of cases, with a comparatively low mortality and excellent end-results. In a recent review of the literature, 184 cases were found in which splenectomy

had been done. It would be strange if, in view of the fact that this is a system disease, removal of only a part of the reticulo-endothelial system would be curative and that no recurrences following splenectomy were to take place. In fact, a number of authors have called attention to this possibility, and have seen cases where recurrence developed, in one patient as early as four months after splenectomy. An interesting observation made on the fragility of the red blood cells following splenectomy in these cases is that though the patients are almost regularly relieved of their symptoms (the anemia and the icterus rapidly disappearing) still the resistance of the red blood cells does not with any regularity increase to the normal.

From this review of the surgical treatment of the various diseases in this group, it is evident that surgery has contributed a great deal to the clarification of the functions of both the healthy and the diseased spleen. Even though at the present time it is difficult to accurately define the indications for splenectomy in many of these cases, and even much more difficult to determine when ligation of the splenic artery should be used instead of splenectomy, still the more carefully the cases are studied and the more completely they are reported, the sooner will the clinician be able to decide upon the value of these two procedures, and in general, upon the indications for surgical attack in these varied clinical pictures.

SURGICAL TECHNIC OF SPLENECTOMY WITH PRESENTATION OF NEW INCISION

By ARTHUR DEAN BEVAN, M D
OF CHICAGO, ILL

I HAVE for some time been making a study of the surgical anatomy and technic of the operation of splenectomy I have done this both on patients and on very fresh postmortem material most of it but a few hours after

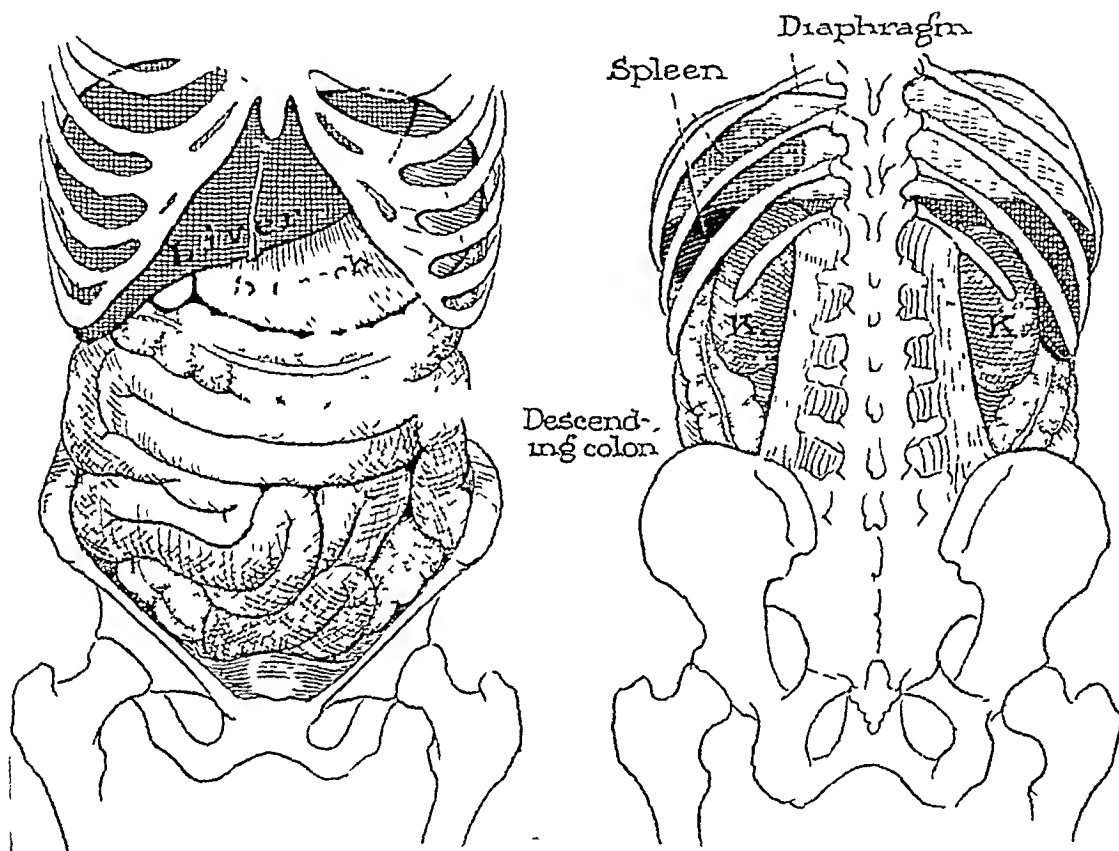


FIG 1 —Anterior view Spleen concealed by abdominal viscera
FIG 2 —Spleen covered by the tenth rib

death, with little change in the tissues I have found these studies have been very interesting, and they have given me a mental conception of the anatomy of the spleen under normal and pathological conditions, which has been most helpful in operative work It is because of this fact that I have ventured to present to you briefly the results of these studies

The spleen is normally a small organ weighing about two-hundred grams, wedged in the posterior portion of the left upper quadrant of the abdominal cavity, completely covered by ribs and completely hidden from view by the surrounding structures even when the abdomen is opened widely This is shown in Fig 1, a front view of the abdominal viscera In Fig 2, I show you the posterior view of the abdominal viscera with the posterior position of the spleen The normal spleen extends from the lower border of

the ninth to the lower border of the eleventh ribs, and the tenth rib covers the centre of the organ and is parallel with its long axis

The spleen is wedged in between the diaphragm and the stomach. The

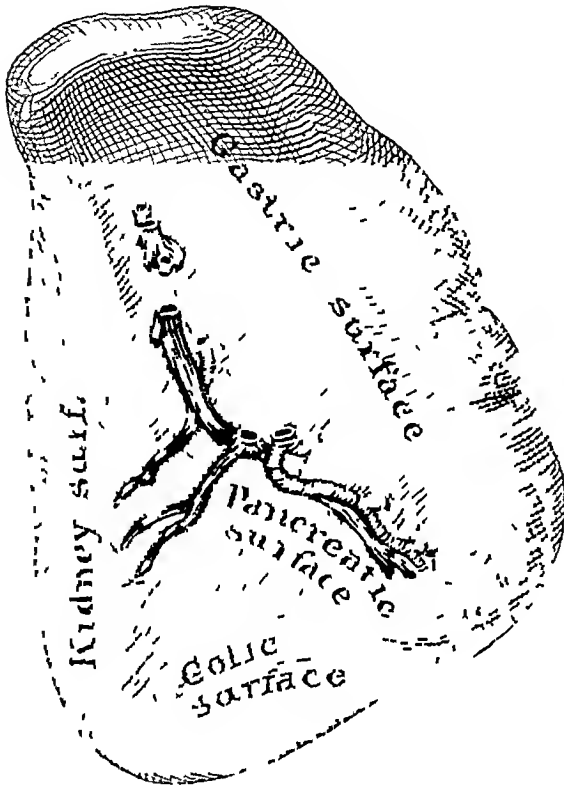


FIG 3 —Concave surface of the spleen

organ has two surfaces, a convex surface in contact with the diaphragm, and a more or less concave surface, called the visceral surface (see Fig 3), divided into two parts by the hilum, an anterior part in contact with the stomach and a posterior in contact with the left kidney. Just below the stomach, and beneath the vessels entering the lower part of the hilum, there is a small surface, called the pancreatic surface which is usually in contact with the end of the tail of the pancreas and below this is a broader area in contact with the colon, called the colic surface, or lower extremity of the spleen. The upper extremity is directed toward the spine. The lower extremity, or colic surface, rests upon the splenic flexure of the colon and is supported by the phrenico-colic ligament. The ante-

rior border is thin and notched, and the posterior rounded.

You will see that the spleen is mosaicked in between the surrounding viscera and diaphragm as a piece of mosaic in a mosaic floor, and much of its support is obtained from this fact. It is, however, supported in part by the fact that it is completely surrounded by peritoneum from which

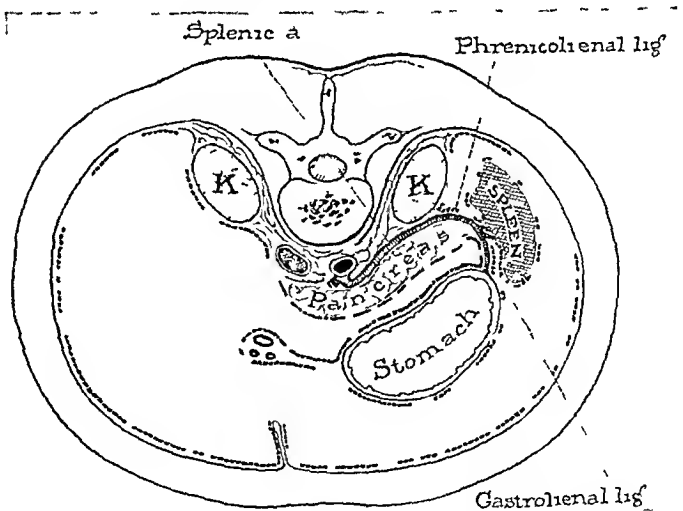


FIG 4 —Cross section showing the spleen and its relations

it receives three peritoneal ligaments which complete its support and hold it in its place in the upper abdominal cavity. These ligaments are the gastro-splenic, the phrenico-splenic and the colico-splenic. In Figure 4 the gastro-splenic and

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the phrenico-splenic ligaments are shown in cross-section. You will note that they are both formed of two layers of peritoneum, one from the greater, and one from the lesser peritoneal cavity.

In Fig 5 is shown the posterior wall of the abdominal cavity showing roots of the mesenteric and peritoneal ligaments which invest the viscera. In the upper left area, you will note the attachment of the phrenico-colic ligament which holds the splenic flexure of the colon in position and which is probably the main support of the spleen, which rests above it.

The blood supply of the spleen is entirely derived from the splenic artery, the largest branch of the celiac plexus, as shown in Fig 6. You will note that the splenic artery supplies branches to the pancreas and stomach and then breaks up into five or six branches which enter the hilum of the spleen. You will note that the splenic artery is tortuous and the relations of the artery are such that as we free the spleen from its peritoneal attachments and rotate it toward the median line we do not

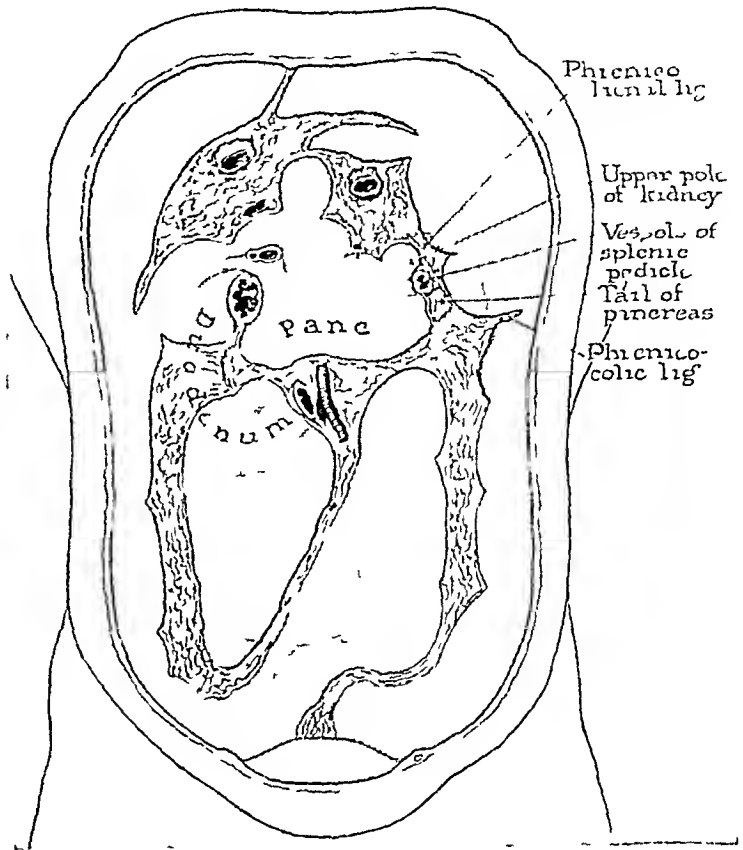


FIG 5—Showing posterior abdominal wall and phrenico-colic ligament

make any traction on its pedicle as we are all the time bringing the pedicle nearer the origin of the splenic artery. The splenic vein begins from the union of five or six veins coming out at the hilum and uniting shortly into a single large vein which is straight, not tortuous like the artery. In pathological conditions these veins may be very large and very thin-walled.

With this knowledge of the anatomy fully mastered, the removal of a normal spleen, as has been done in splenic anemia, is a comparatively simple matter. It resolves itself into freeing the peritoneal attachments carefully with the wet-gloved hand without tearing into the spleen pulp, rotating the spleen on its pedicle forward and inward, carrying the stomach and pancreas with it, bringing it out of the incision which may be a simple median one, and dealing with the pedicle by ligating the five or six veins and arteries in five or six separate ligatures, care, of course, being taken not to injure the tail of the pancreas. (See Fig 7.) In pathological conditions of the spleen requiring splenectomy, there may be enlargement of the spleen, perisplenitis, or dis-

placement of the spleen, which change the normal anatomy and require special study. Enlargement of the spleen may change the normal spleen weighing 200 grams to one weighing 2000 grams, and with this enlargement the anatomical picture is greatly altered. The 2000 gram spleen fills the entire left hypochondrium, pushes the stomach to the right, slides over the transverse colon and splenic flexure and descending colon, and comes to occupy the greater part of the left abdomen.

The distance from the hilum to the origin of the splenic artery is short-

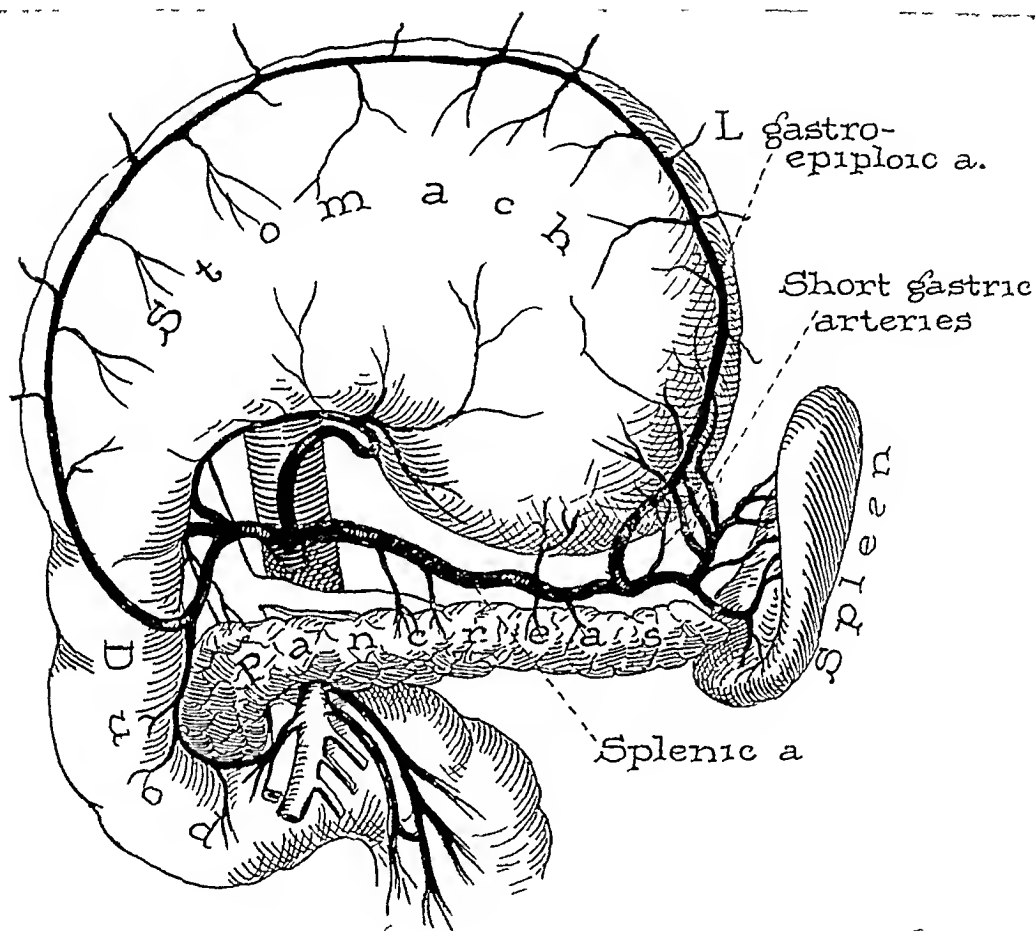


FIG 6—Arterial supply of spleen, stomach and pancreas

ened, the hilum comes much nearer the median line. Splenectomy in splenomegaly, even of good size without perisplenitis and adhesions, may be with adequate incision and exposure a simple matter and mean simply careful freeing of the spleen from its peritoneal attachments, rotating the organ inward and downward and ligating separately the vessels at the hilum. Splenomegaly with perisplenitis and adhesions may furnish the operator doing a splenectomy one of the most difficult problems in surgery, here adequate exposure is essential. One cannot tell with absolute certainty before opening the abdomen whether the spleen is adherent or not, on that account, the surgeon must be prepared to handle either a simple or a difficult splenectomy. My studies have been directed to meet this situation as far as it can be met.

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Many plans of incision have been suggested and carried out in the operation of splenectomy, a midline incision, an incision through the left rectus saving the nerve supply, by keeping the greater part of the muscles to the outer side of the incision, or all the muscle to the outer side as Moynihan has done, an incision parallel with the costal arch, resecting the costal arch, etc

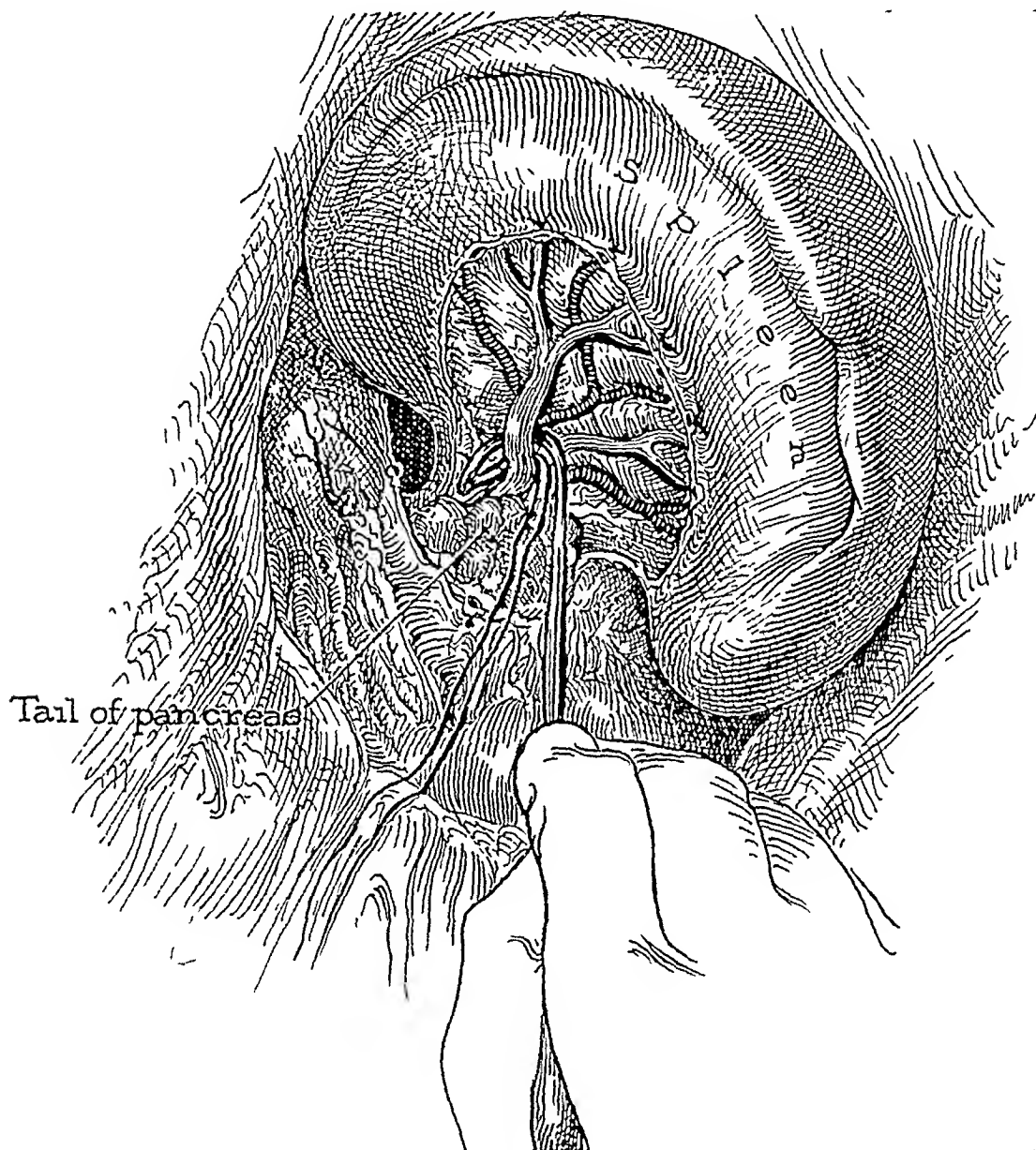
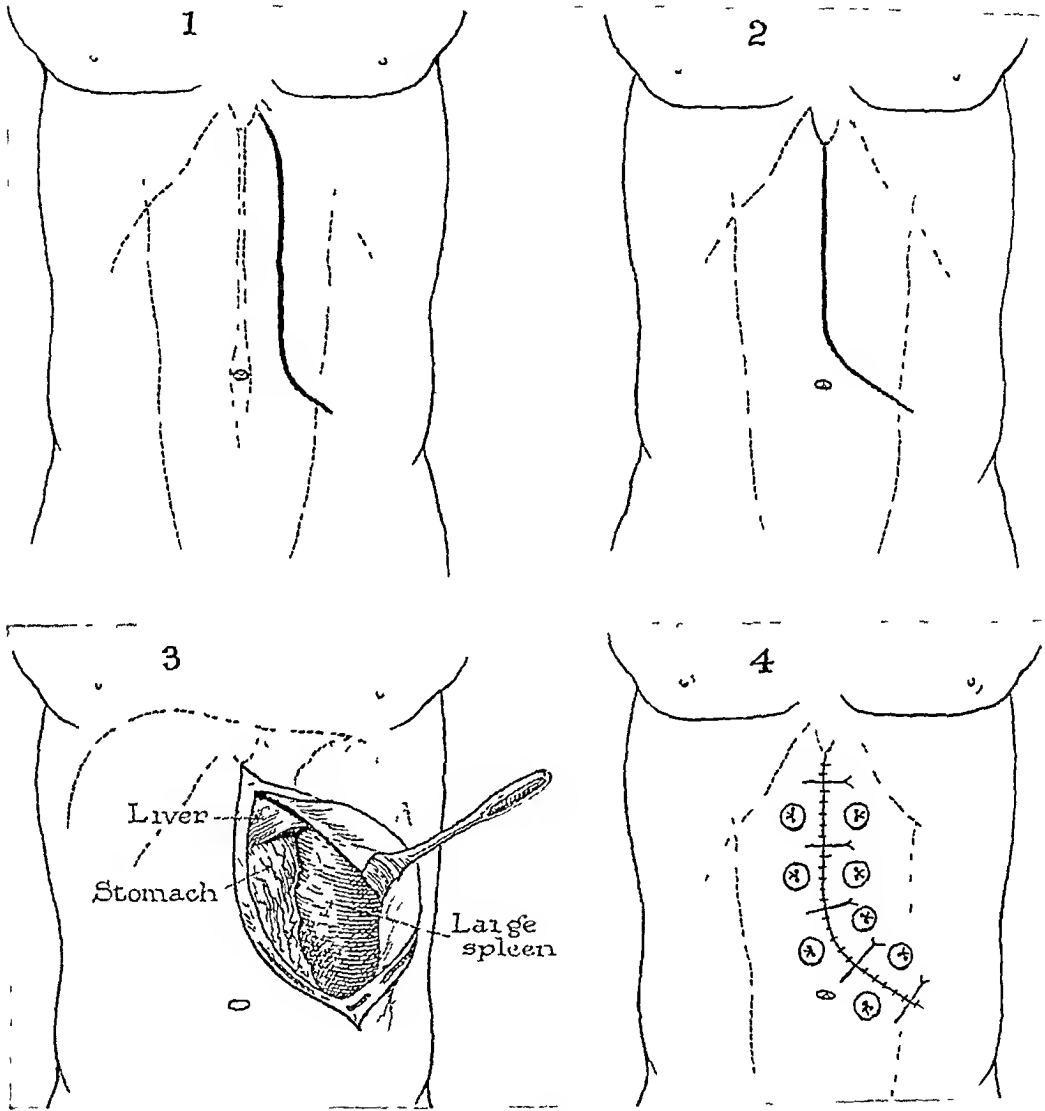


FIG 7—Ligating splenic vessels

For some time I used a large S-shaped incision through the left rectus, saving the nerve supply by keeping almost all the muscle to the outer side, making the incision of sufficient length, as a rule extending it downward almost to the lower end of the enlarged spleen, and then, if extensive adhesions or other conditions demanded, curved the incision three or more inches outward dividing the rectus so that a huge flap could be turned upward and outward exposing the spleen and all the structures in the right upper quadrant of the abdomen, even the entire left half of the diaphragm (See 1, Fig 8)

This incision is a very useful one but for several years now I have simplified and improved it as a result of operative and cadaver studies. I am now using for the small splenomegalies and the simple cases a straight midline incision.

This incision begins in the left angle between the ensiform and the costal arch. It is carried downward in the midline to just above the lower border of the enlarged spleen. For the ordinary case of splenomegaly, this long midline incision will suffice.



1 — Old Bevan incision
3 — Exposure obtained

FIG 8

2 — New Bevan incision
4 — Closure

Where because of adhesions, or other difficulties, additional room is required, the incision should be enlarged by dividing the rectus as shown in 2, 3, and 4, Fig 8. This will give the largest possible exposure as you can demonstrate on the patient or fresh cadaver (Figs 10, 11). The closure is made in the usual way with the addition of five or six sets of large button tension sutures. I have been surprised and very much gratified to find such a simple and satisfactory solution to this problem.

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These incisions carry little risk of hernia as there is no injury to the nerve supply of the abdominal wall. See Fig 9, showing the nerve supply. They can give adequate exposure in all cases.

With the full and complete knowledge of the surgical anatomy involved the spleen can be freed from the surrounding peritoneum, usually by the sense of touch with the wet-gloved hand. If adhesions are present these can be for the most part exposed and cared for under the eye. I can see little place for the use of clamps to clamp the pedicle in splenectomy. I am quite converted to the position that ligating the vessels separately is much the safer and better way. Packing the space from which the spleen has been freed with large packs wrung out of very hot normal salt solution, as suggested by W. H. Mayo, is of distinct value, normal salt solution seems to be of greater value in producing coagulation than sterile water. Occasionally a layer of peritoneum binds the spleen to the diaphragm firmly and is difficult to separate with moderate force with the gloved finger. In these cases one can leave this to the last and ligate first the pedicle proper, and then between clamps divide this peritoneal adhesion or ligament.

The wound should be closed, if possible, without damage. If it is necessary to leave in a pack to control bleeding from a large surface, this should be removed under gas anaesthesia forty-eight to seventy-two hours later, and the wound closed completely except for a rubber tube left in down to the site from which the packing has been removed. If possible this tube should be shortened daily and removed entirely within a few days.

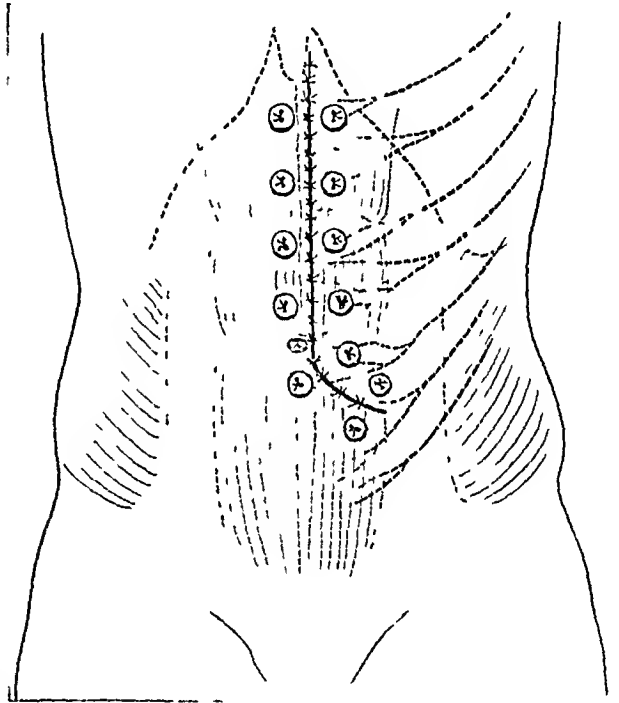


FIG 9 —Showing incision and the nerve supply and closure

I believe that it is well worth while for anyone undertaking this work to make a careful study of the anatomy involved in splenectomy on a dozen or more perfectly fresh cadavers. The best way to secure this material is to arrange with some friendly pathologist to have the opportunity of making abdominal incisions and study the spleen for a half hour before he makes his postmortem examination. This will give you a conception of this field which will prove to be of great service to you in your operative work.

I would urge a trial of the spleen incision which I have described.

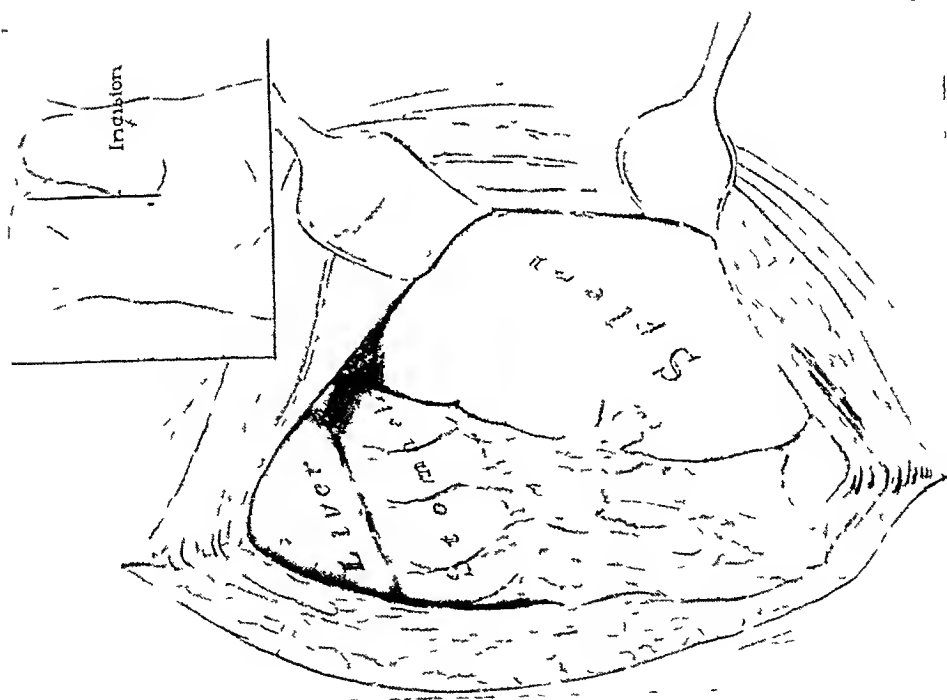


FIG 10.—The exposure obtained by a very long midline incision

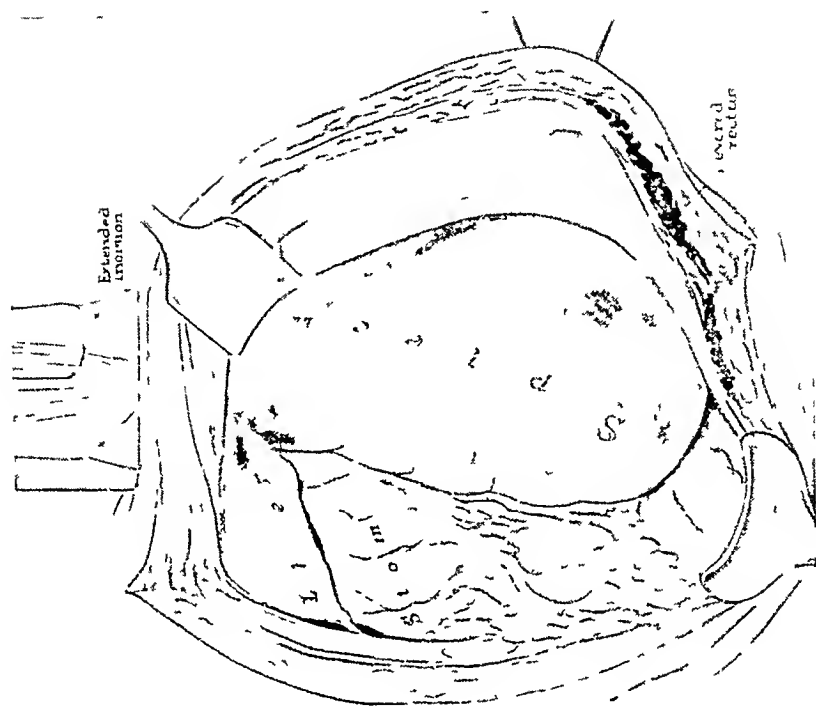


FIG 11.—Much greater exposure obtained by extended incision which divides the rectus muscle

SPLENIC ENLARGEMENT WITH CIRRHOSIS OF THE LIVER

(BANTI'S SYNDROME)

BY JOHN B DEEVER, M D

AND

S P REIMANN, M D (BY INVITATION)

OF PHILADELPHIA, PA

SINCE good surgery aims to produce physiological effects for definite purposes, the results obtained will depend on the surgeon's conception of the pre-operative conditions and on his idea of how he wants to change them. But with the spleen, our knowledge of the physiology is less precise than that of many other surgical conditions, our ultimate aim is—naturally, cure of the patient, but since our working knowledge of splenic diseases is limited, our conception of how we want to accomplish a cure is also limited. So we just grossly extirpate the organ and watch for results, trying to fit them to the maze of theories which surrounds the status of the function of the organ. We find but a hazy path mapped for us in the diseased spleen, and we know so little of what occurs after we have removed the organ. Fortunately, however, there are a number of beacon lights which point the way for our surgery, empiric though it is at present. In Banti's disease, we know by experience that well-selected cases are cured by splenectomy, but unfortunately, selection of the proper case is not subject to any very definite criterion, except that the spleen must be removed early, before changes, which we are pleased to call secondary, have occurred. And yet splenectomy sometimes proves beneficial in late cases. Much to our surprise, the following patient recovered extraordinarily well. Man fifty-two, three years previously had hæmatemesis and melena, mild pain in upper abdomen, treated for a year for peptic ulcer, at which time enlarged spleen and moderate anemia were noted. On admission, his spleen reached to the symphysis, was quite hard, and more or less fixed, liver also enlarged, edge palpable, very hard, considerable ascites. He was tapped once, and ten litres of fluid removed from the abdominal cavity. Blood count showed 60 hæmoglobin, 2,500,000 red cells. He vomited small amounts of blood several times. General appearance cachectic. Splenectomy performed after transfusion and followed by transfusion. Patient was tapped five times during a period of eight months after the operation, smaller amounts being obtained at each tapping until merely a quart was obtained at the last tapping. Hæmoglobin one year after operation, 80 per cent, 4,250,000 reds, white cell count normal. Strength below par, but very much increased. Apparently splenectomy has prolonged his life, undoubtedly it increased his usefulness. And yet this was a late case. It is seldom easy to distinguish a primary from a secondary splenomegaly, especially clinically, not a little because one of the ways we use to say that the spleen is the "primary" source

of the trouble, is to discover that a cure results when the spleen is removed. So let us examine our experience to see how accurately we can tell when the spleen should be removed, at least to a degree sufficient to satisfy our present practical needs.

But first, let us consider some of the ideas concerning the function of the spleen. It is not an organ necessary to life, for it can be removed and the patient continues to live in quite comfortable health, qualified, however, by the statement that its presence or absence may make considerable difference when certain emergencies arise. For example, in certain animals, at least, the spleen contains so large an amount of blood, apparently so well "sheltered" from transient deleterious influences, that if the animal is quickly poisoned with carbon monoxide gas, enough blood can be sent into the general circulation from the spleen to spare the life of the animal. Animals which have been splenectomized have no such reservoir of good blood to tide them over the emergency. Probably other demands, more physiological, are made upon this organ from time to time. It can produce red blood-cells in adults as a resumption of a fetal function, when demands are made. The part played by the spleen in the destruction of worn out blood cells is quite important. The exact mechanism is still under consideration, but according to good evidence, many red blood-cells are destroyed in the circulating blood, being prepared for destruction in the spleen perhaps, and then their products are phagocytosed in the spleen. It stores iron against future needs, it has to do with the transformation of hæmatoidin from broken down hæmoglobin into bilirubin. It has something to do with antibody formation, possibly it helps in resistance to certain infections, it surely has more resistance to secondary tumor growth than most other organs. The less said about its relation to metabolism the better, since authorities are in utter disagreement. Its relation to the lymph-nodes, the bone marrow and the whole reticulo-endothelial apparatus is shown by the behavior of those structures after splenectomy.

To sum up, just as we may, for purposes of convenience, divide diseases of the spleen into primary and secondary ones, so we might divide its functions into primary and secondary ones, that is, we may consider primary, those functions which the spleen itself has, and those secondary, which the spleen shares very intimately with other organs, specifically, the lymph-nodes, the bone marrow and the reticulo-endothelial apparatus. We might consider its reservoir function a primary one, since, when the spleen is removed, this is gone. We might also consider its contributions to the liver by way of the splenic vein, a primary function, since, when splenectomy is performed, while some of this function is taken over, no doubt, by the remainder of the reticulo-endothelial system, the latter nevertheless, is not so intimately connected with the liver, which interests us in Banti's disease. And yet perhaps it is more so, since Kupffer's cells right in the liver are very important parts of the reticulo-endothelial system. Such functions as the formation of antibodies, etc., might well be called secondary, because when the spleen is removed, they are taken up so quickly by other organs.

SPLENIC ENLARGEMENT WITH CIRRHOSIS OF THE LIVER

In disease, we can quickly list conditions in which the spleen is secondarily involved, or is only one of many parts diseased. We mention the leukemias, continuing through malaria, syphilis, to enlargements due to chronic passive congestion from central, cardiac, peripheral, and portal causes. Gaucher's disease may begin in the spleen, but in our experience with three cases, removal of the spleen quite early led to no cessation of the condition, for these patients died later of general involvement of the reticulo-endothelial apparatus, one child operated at eight, dying eleven years later. This leaves us to consider the diseases apparently beginning in the spleen, exclusive of tumors, of course. What have they in common? First, the etiology is unknown, immediately the etiology is known, the condition automatically ceases to be one of them. Second, there is splenomegaly, leading to a weight seldom less than 500 gms and seldom more than 2000 gms. There is anemia, moderate, and of the secondary type. Then the symptoms present individual peculiarities. Some patients have hemorrhages, petechial, so that a veritable purpura is produced, or larger, as melena or hæmatemesis. Some show a slight jaundice from the beginning, others show paroxysmal jaundice with biliuria, and even hæmoglobinuria. Some show rapid loss of strength and weight, others maintain good nutrition, some develop cirrhosis of the liver early and rapidly, some apparently do not develop this condition at all, others begin to develop cirrhosis after a long period of time, years perhaps, whereupon it may occur quickly or slowly, some develop ascites early, others late, or not at all. These and other symptoms make it no more probable that we are dealing with a uniform condition than that we are dealing with jaundice, which, as we all know, was at one time considered a disease *per se*. How shall we approach these puzzles? Perhaps it is better at present to consider them variations of one and the same thing as far as treatment is concerned, but as riddles, soluble in the future as far as their philosophy is concerned.

The complex first described by Banti in 1882, and bearing his name, still remains a distinct disease entity, in spite of efforts to prove it to be secondary to infection and various other conditions. With others, we consider it so much a primary disease, that where there is the least hint of a real etiology, we cease to think of it as Banti's disease, a view which will, in all probability, require modification, but one which is still useful at present. In other words, what you do know, immediately proves that what you do not know is not present.

The disease is characterized by chronicity, although some few cases run a fairly rapid course, it begins with splenomegaly from progressive indurating connective tissue proliferation, and anemia of moderate degree somewhat similar to rather severe chlorosis, a stage lasting sometimes for years. This is followed by enlargement of the liver progressing through a year to eighteen months, with or without mild icterus. This is then followed by the ominous shrinking of the liver, and its secondary manifestations of ascites and other signs of Laennec's cirrhosis. Severe icterus and the hemorrhagic diathesis are not very common. The spleen attains a certain size and remains so, when liver

shrinkage begins, death occurs in approximately one year. The enlargement of the spleen, at this stage, seldom less than 1000 gms, is much greater than occurs in ordinary liver cirrhosis, in which the spleen is also enlarged. The anemia in all probability is due not so much to increased blood destruction, as to diminished blood formation, there is a lack of normoblasts, reticulated cells, etc. Probably the best view is that some toxic or infectious, but extremely poorly defined substances, are formed in the spleen which lead to fibrosis of this organ, to inhibition of the bone marrow, and to the secondary cirrhosis of the liver. Parenthetically, the cirrhosis of the liver begins very frequently in the left lobe, and at all stages is likely to be more marked in this lobe than in the right, for anatomical reasons, such as we have described in other communications.

The diagnosis then rests, first on enlargement of the spleen for no apparent cause, in an otherwise fairly healthy individual. The examination of the blood reveals an anemia, sometimes like that of a secondary anemia, at other times resembling chlorosis. There are few, if any, normoblasts and reticulated cells. Great care must be exercised in the examination of the white cells, for aleukemic leukemias occur with enlargement of the spleen, and examination of the blood in this condition, or at the time of aleukemia may show normal numbers, and even a normal differential count, although sometimes abnormal white cells are discovered. Frequently also, in aleukemic leukemia, the tendency is for other lymphoid structures to be enlarged, whereas in Banti's disease, it is the spleen and the spleen alone. The greatest difficulty is afforded by cases of primary cirrhosis of the liver in which the spleen is enlarged, but seldom to the same extent as in primary Banti's disease, to which might be added that in true Banti's disease, when the liver is cirrhotic, the chances of cure by splenomegaly are unpromising, with exceptions, however, as noted above. Given a somewhat cirrhotic liver at operation, it is always much more fibrosed in Laennec's cirrhosis as compared to the size of the spleen, than it is in Banti's disease, except in the terminal stages. In other words, the spleen is very much larger in proportion to the damage in the liver in any case of Banti's disease. Other criteria for the differentiation of splenomegaly secondary to cirrhosis of the liver, and splenomegaly primary and occurring before cirrhosis of the liver are as follows.

The spleen in Banti's disease is tougher in consistency than in cirrhosis. Peri-splenic adhesions may or may not be present. Previous X-ray treatment may stimulate them, although this is extremely difficult to determine, because we do not know what was there, or what would have been there if X-ray treatment had not been instituted. As an example, a man twenty-eight years old was operated about six weeks ago, his only complaint being a very much enlarged spleen which made his abdomen feel heavy, and interfered with his agility as a structural steel erector. He had no anemia and no symptoms of any kind. This enlarged spleen had been noticed for two years and had been treated on three successive occasions quite intensively with the X-ray, the organ shrinking considerably the first time, the second time less and the third

SPLENIC ENLARGEMENT WITH CIRRHOSIS OF THE LIVER

time scarcely at all. He came to us four weeks after the last of his three series of X-ray treatments. He had no anemia, but a leukopenia of 2000. The white blood-cells increased to practically a normal count over a period of two weeks, the most obvious cause of the leukopenia being the X-ray treatment. At operation, his spleen was found adherent superiorly and posteriorly, but was easily delivered and removed. It weighed 2300 grams. He made a good operative recovery. What effect the X-ray had in producing the adhesions is unknown. A sclerosing phlebitis is common in Banti's disease and unusual in secondary splenomegalies. This condition makes for technical difficulties in isolating and ligating the vessels. The spleen in Banti's disease on section is a lighter red than the spleen secondary to cirrhosis of the liver, and much lighter red than that of a spleen secondary to cardiac decompensation. There is less blood present in Banti's disease than in either of the other conditions. Furthermore, it is finer, denser, fleshier, early, the follicles perhaps are more prominent because of fibrosis around central arterioles, later, the follicles and pulp are indistinguishable because the fibrosis, as it spreads centrifugally from the centres of Malpighian follicles, is met by a fibrosis which began in the pulp. The reason for less blood is found microscopically, there is narrowing of cavernous veins and sinusoids from reticulum fibre thickening and fibrosis. The spleen in cirrhosis and other conditions will probably show dilatation of the sinusoids and endothelial hyperplasia. There is little blood pigment in the spleen of Banti's disease.

To sum up, our rationale in any case of splenomegaly is to hunt for all possible etiologies. Failing in this, we consider the case a primary splenomegaly from the criteria above discussed. We contemplate, then, the removal of the spleen. This is governed, to a certain extent, by the time of the disease, by the presence or absence, as far as can be determined, of the secondary cirrhosis of the liver, by the blood count and by the serious symptoms of bleeding. Transfusion before operation is indicated when the hæmoglobin is below 50 per cent. At all events, donors are ready for transfusion after the operation, because not only may there be considerable venous oozing from adhesions, but the enlarged spleen, weighing sometimes 2000 grams, contains a considerable amount of blood which is lost to the patient. Operation is, therefore, never done hastily and without careful prolonged study of the patient. The effects of radium or X-ray treatment in temporarily reducing the size of the tumor are sometimes utilized in order that the tumor be smaller for the operative procedure. In any event, the operation is not an easy one, both because of the patient's condition, and because of inherent technical difficulties, especially since most of the cases come to operation in an advanced stage of the disease when adhesions are sure to be present, so that the vessels in the pedicle are apt to be sclerosed, and the capsule of the organ is easily torn. Unless the spleen is enormously enlarged, the pedicle can be reached anteriorly after the stomach has been drawn well to the right and the gastro-splenic omentum has been divided. In order best to reach the vessels in the pedicle, any adhesions present should be separated and the spleno-phrenic fold

of peritoneum divided, after which the spleen is turned over and the vessels are seen. This is, however, not always a simple procedure. The adhesions are apt to be dense, and may contain large veins which must be divided, as the spleen is gradually mobilized. Venous oozing must be controlled by hot gauze packs in the splenic bed. With the gastric or under surface of the spleen thus exposed and drawn into the wound, the vessels in the pedicle are cut, great care being taken to avoid injuring the tail of the pancreas. The ligatures are applied separately to each vessel as it is identified, and the vessels cut as close as possible to the spleen. After bleeding from the pedicle has been controlled, the packs are removed, bleeding in the subphrenic space is checked and the abdominal incision closed after absolute hemostasis. No drainage is used.

In the after care, if the immediate shock and loss of blood, if present, are successfully combated, the patients usually recover from the operation quite uneventfully. Since we know of no specific cause of the disease outside of the hypothetical noxæ in the spleen which is now removed, we have no specific advice to give the patients, beyond general care and attention. It is our experience, that when the patient has come to us early without much reduction in strength, recovery after the operation is quite rapid and satisfactory, but in patients such as the first quoted, there may remain an invalidism, lasting for a long time, but, with few exceptions, an invalidism which is considerably less than was present before splenectomy. Most patients who were previously unable to work can at least work at something, a few months after operative recovery. Blood counts have been made post-operatively in all of our patients, some extending over years. Some have blood which is not quite normal, there being some little change in the morphology of the cells, or a slight anemia, or a slight leukocytosis, at least something not quite normal. This is contrasted with others with normal blood counts, and several patients splenectomized for traumatic rupture of the spleen, in whom, after a number of months, the blood count returned to normal. We have had no recent opportunity to examine a patient some time after splenectomy, to discover whether any of our patients developed the curious hyperplasia of the abdominal lymph-nodes, or developed an accessory spleen such as is described in the literature. To sum up, briefly, we feel that splenectomy, if it has not cured completely some of our patients, has at least cured a few, and has rendered all of them more useful citizens and better able to do some daily tasks.

UNCLASSIFIED TYPE OF SPLENOMEGALY IN CHILDREN

BY JAMES MORLEY HITZROT, M D

OF NEW YORK, N Y

ENLARGEMENT of the spleen in children while not rare is not common and the various varieties bear a close resemblance to the splenomegalies found in adults

Aballi (*Vida Nueva*, Havana, vol xx, pp 333-504, Dec, 1927) in 7200 children found 470 with enlarged spleens The enlargement was due to syphilis in 170, intestinal parasites thirty, malaria thirty Anæmias of the various types as well as hæmolytic jaundice are not common in Cuba and the cases of von Jaksch's anæmia were in most cases due to syphilis

Among the diseases of the blood with anæmia in children, malaria, syphilis, rickets, von Jaksch's anæmia, hæmolytic icterus, the purpuras, Gaucher's disease and certain congenital differences in liver size with splenomegaly are among the more frequent forms

During the past fourteen years, four unusual cases of splenomegaly with anæmia in children have come to splenectomy at the New York Hospital, and which have, as time has elapsed, made us question our original diagnosis The first case Margaret M was reported by Stillman (*American Journal of Medical Sciences*, Feb, 1917, vol ciii, p 18, Case 1) and by me in the same year (Published report—*ANNALS OF SURGERY*, May, 1918, Case 10) as a case of von Jaksch's anæmia The other three cases have not been reported previously All three were members of the same family (See Diagram 1)

The main event which has given us cause to wonder just where these cases belong in the group of splenomegalies is the result of the shower of nucleated red cells which appeared immediately after the splenectomy, and which in Case 1 has persisted for fourteen years, the nucleated red cells remaining five to one in the differential blood count up to the present

Alvaro B Case 2, operated on in 1920 had a similar shower of nucleated red cells with other variations in the red cell a little more marked than Case 1, but with the same persistence of the nucleated red cells for eight years In this case the nucleated red cells have been five to eight times the nucleated white cells and are a predominant feature in the smear at present and have been so throughout

Armando B Case 3, operated on in 1920 (brother of Case 2) showed the same shower of nucleated red cells immediately after splenectomy and this condition persisted up to the time of his death from acute meningitis, in 1922

Victoria B Case 4 (sister of Cases 2 and 3), splenectomy in 1922, showed a similar shower of nucleated red cells five to eight times the white cells following splenectomy and this has persisted for six years

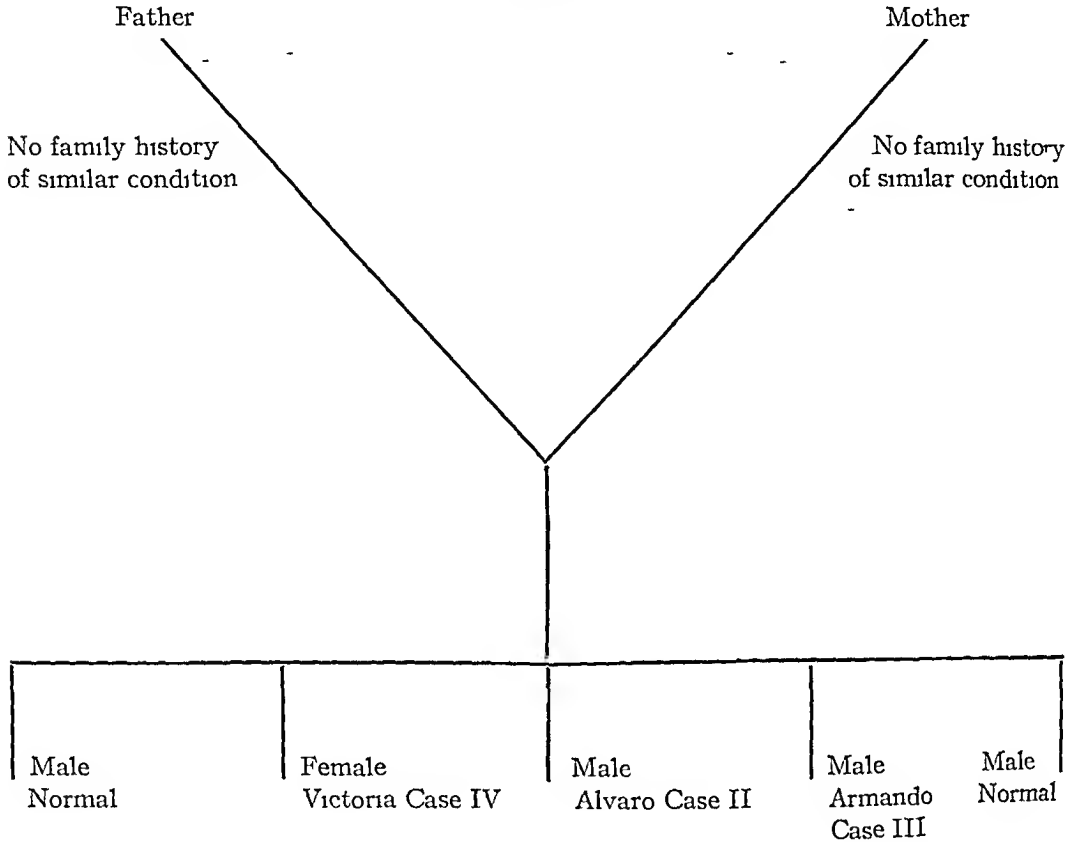
All the above cases showed a few nucleated red cells previous to the operation, but the high percentage following splenectomy has struck us as a

peculiarly constant feature not present in the other cases of splenectomy in children which we have studied

Nucleated red cells are present in anæmia in children from various causes but not in such large numbers

Hirshfeld (*Ensykld Klin Med*, Berlin, 1920) states that nucleated red cells are commonly found in the blood in von Jaksch's anæmia and rarely may

DIAGRAM I
Bellua



be present in as high a number as 1000 to 2000 per c mm In addition to normoblasts, megaloblasts are also of common occurrence

Ostrowski (*Jahr f Kinderheilk*, 73, 1911) found numerous nucleated red cells in the bone marrow in cases of von Jaksch's anæmia

Cooley, Witwer and Lee (*American Journal Diseases of Children*, vol xxxiv, pp 347, 363, Sept, 1927) report seven cases of splenomegaly in children with bone changes which closely resemble Case 3 in this series They consider the type as—"a form of hæmolytic anæmia developing in early life and dependent upon some congenital defect in the hæmolytopoietic system Clinically some resemble von Jaksch's anæmia while others resemble an atypical hæmolytic jaundice"

They give the following reasons for a definite clinical grouping

- 1 Congenital cause Hereditary syphilis is not a factor
- 2 Blood picture Striking evidence of bone marrow stimulation An absence of increased red cell fragility Marked nucleated red cell increase

UNCLASSIFIED TYPE OF SPLENOMEGALY IN CHILDREN

3 Hæmolysis They believe the skin pigmentation is evidence of a chronic hæmolysis

4 Bone changes Curious striation of the long bones with thinning of the cortex as evidenced by the X-ray Skull changes due to increased width of the diploe and thickening and striation of the outer table (Gansslen "Turmschaedel" in the familial type of hæmolytic icterus are considered similar, *Deutsch Archiv f klin Med*, pp 140-210, 1922) Cooley found no similar changes in the bones in rickets, syphilis or the non-hæmolytic anæmias

5 Peculiar facial appearance Mongolian facies, with thick cranial bones and prominent malar bones

Other observers (von Jaksch, Wieland, Cleve, Lehdorf, Pianese) have described nucleated red cells in the blood as a frequent feature in von Jaksch's anæmia and Hayem and the French observers have reported frequent nucleated red blood cells in hæmolytic icterus, but neither Stillman nor myself have been able to find descriptions of a blood picture which in any way simulates the enormous number of nucleated red cells (220,000 per cmm, or higher) which have appeared after splenectomy in the cases here reported



FIG 1—Tibia and fibula Note thin cortex and cross striations in the medullary bone

Krumbhaar (*The Spleen and Anemia*, Phila, 1918) considers Case 1 as a type of hæmatogenous icterus but in this condition, be it the acquired or the familial type, we have found no reference to a similar blood picture following splenectomy

Another feature in all four cases is the onset of the disease in the second year with the appearance of a curious tint to the skin, bluish-white sclera, vomiting, loss of appetite and weakness The onset was most acute in Case 3, and less marked in Cases 1 and 4, but all had a definite period at which the above symptoms predominated

The third feature of interest was the lack of growth and development in these children This was most marked in Case 1, who at nine years looked like a girl of three and in Case 4, who at fourteen looked about

eight years of age, and in all the cases sufficiently old to test their mental reactions these approximated the age appearance rather than that normal for their respective ages

This arrested development was also markedly altered following splenectomy and in two of the cases (Case 1 and Case 2), after a short interval, they began to grow normally and to develop the mental traits characteristic of their real age. In Case 1 these changes were so marked that at the end of the first year the child seemed a different individual. In the girls, menstruation and puberty were both delayed, probably due to the anæmia, and in Case 4

it appeared at approximately the same period (sixteen-seventeen years) as in Case 1. The living boy, Case 2, has not yet reached puberty. Case 2 showed a number of skeletal changes, namely defects in the development of the bones of the skull, thickening of the skull with a curious striation of the outer table and thinning of the cortex and striation of the long bones (see case report) and of the teeth (X-rays). Similar changes have not appeared in the other cases.

At no time have any of these children shown

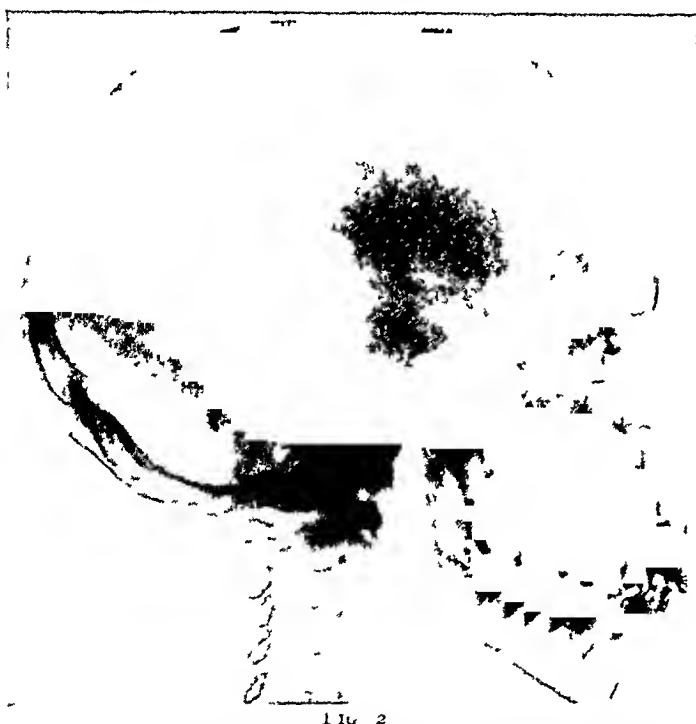


FIG 2 and 2a—Skull. Note thickening of the diploe and striations in the outer table with the relative increase in thickness of the outer table

any symptoms characteristic of rickets, nor have the X-ray pictures of their long bones shown any of the lesions of the epiphyses characteristic of rickets.

Syphilis as a factor in all four cases can be eliminated if a negative Wassermann is trustworthy. The parents and the children have given negative Wassermann reactions in both antigens on more than one occasion.

The question of classifying them as types of hæmatogenous icterus seemingly can be denied.

The reaction to hypotonic salt solution is but little different from normal H_1 0.6, 0.56, H_3 0.35 to 0.25 and the resistance was increased slightly after splenectomy H_1 0.68, 0.63, H_3 0.49 to 0.25.

Urobilin was present in traces in the urine and in the blood but never in excess and there never was any trace of jaundice on the skin or on the sclera. The sclerae in fact were bluish-white and more characteristic of a high grade anæmia than of jaundice.

In the three cases in the same family the familial type of hæmatogenous

UNCLASSIFIED TYPE OF SPLENOMEGALY IN CHILDREN

icterus seemingly can be eliminated as iso-agglutination of the red cells was not present in any of the three cases and there was no obtainable history of a familial jaundice on either the paternal or the maternal side and other children in the same family were normal

Except in Case 1, malaria did not enter as a possible factor and in Case 1 Stillman doubts it as a factor and repeated examinations of the blood and smears of the spleen failed to show any evidence of malaria

In none of these cases were any intestinal parasites found

The pathological reports upon the four spleens do not help in making any definite diagnosis Case 1 was considered as significant of von Jaksch's anæ-



FIG 2a

mia by Stillman It contained a much larger percentage of myelocytes than was found in the other cases This was also the largest spleen, weight 1420 gms The smallest spleen (Case 3) weighed 432 gms

In the other spleens there was no hyperplasia of the pulp cells, the Malpighian bodies seemed normal, the capsule and the trabeculæ were not thickened There was no evidence of myeloidization and except for a slight increase in the blood content there was nothing significant

Doctor Elser stated that the structural changes in the spleen are relatively slight and are not characteristic of any definite clinical condition

CASE REPORTS

CASE I—Margaret M, age nine years, was admitted to Doctor Conner's service April 19, 1913 Family history negative She had had measles in infancy, but gave no history of rickets, at two years of age she had an attack of malaria and since that time her spleen has been persistently large Malarial organisms had never been demonstrated in her blood, at the time of the first attack she was living in a district in which malaria

was prevalent, and for the next six years she suffered yearly with attacks of intermittent chills and fever. Patient well nourished and developed. Heart enlarged, apical impulse tapping, and a blowing systolic murmur was heard at the apex and transmitted but a short distance into the axilla. The liver dulness extended from the fourth rib to 8 cm below the costal margin. The splenic dulness began in the axilla at the eighth rib, and the organ almost filled the left flank, extending to 14 cm below the costal margin and almost to the median line at the level of the umbilicus. The spleen was hard and smooth and not tender. There were large, slightly tender glands under the angle of the jaw. Weight forty-seven pounds. Eye-grounds and ears negative. Blood cultures and Was-

sermann negative. Von Pirquet test faintly positive. The stools constantly positive for stercobilin and negative for bilirubin and blood. The urine showed a varying output of albumin, from none up to a heavy precipitate, with occasionally a few casts. Urobilin was constantly present. The phenolsulphonephthalein output was 80 per cent in two hours. The red cells 2,300,000, hæmoglobin 25 per cent, color index 0.5. White cells 8100, polymorphonuclears 58 per cent, lymphocytes 36 per cent, eosinophiles 1 per cent. The red cells exhibited marked poikilocytosis, anisocytosis, polychromatophilia, and basophilic granulation. There were fifty-three nucleated red cells for every 100 whites, 4300 per cmm. A test of the resistance of the red cells showed that hæmolysis began at 0.62 per cent NaCl, and was complete



FIG 3—Humerus and radius and ulna. Note conditions similar to that in Fig 1 with more pronounced cross striations

at 0.44 per cent. Vital staining cells made up about 35 per cent of the total number of red cells. Repeated attempts to find malarial parasites were unsuccessful. One examination of blood serum showed no urobilin but a faint trace of bilirubin.

Her temperature varied between 100 and 102 degrees. She was given arsenic until her tolerance limit was reached, and then put upon quinin, a few doses intravenously, but most by mouth. Following the administration of the quinin her temperature fell during two days from 101 to 98 but later rose again. During her second week in the hospital she developed a dry pleurisy which was relieved by strapping. Her red cells rose gradually to 3,900,000 and hæmoglobin to 43 per cent, the index remaining at about 0.5. The nucleated red cells rose to 121 for every 100 white cells, fell to 3 and later rose again to 27, but were constantly present. Megaloblasts were found constantly. The white cells varied somewhat, but rose to 13,500 before her discharge on June 16, 1913.

She was much improved and spent the summer in the country, in the fall she complained of pains in her legs and weakness and began to lose ground. She was taken out of school, gradually became worse and was unable to get about. She was readmitted to the hospital, January 12, 1914, at which time she showed marked pallor of the skin and

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mucous membranes The heart signs were essentially the same as on former admission The liver dulness extended from the fifth rib to 10 cm below the costal margin The spleen had increased in size and now extended to within two fingers breadths of the symphysis and 2 cm across the median line The lymph-nodes were not generally enlarged Red cells numbered 2,400,000, hæmoglobin 25 per cent, color index 0.5 White cells were 15,000, polymorphonuclears 40 per cent The nucleated red cells were present constantly in small numbers Her weight was forty-seven pounds Urine showed only a faint trace of albumin and no casts Temperature between 100 and 103 degrees During the next two months she received arsenic most of the time She showed no improvement and she



FIG 4—Femur and pelvis Condition similar to that in Figs 1 and 3 Note width of rami of ischium and pubis

was transferred to the First Surgical Division and Doctor Hitzrot did a splenectomy on March 21, 1914

Splenectomy—High left rectus incision, no free fluid in abdomen Moderate amount of perisplenitis with adhesions to under surface of diaphragm, to coils of the small intestines at the lower pole, omental adhesions about hilum and anterior border Adhesions separated by blunt dissection, the vascular ones cut between ligatures After freeing the spleen on all sides a heavy clamp was placed on pedicle and pedicle tied, spleen removed and ligature tied a second time about the pedicle Hæmostasis was good, some slight oozing from adhesions that had been broken up Peritoneum closed with plain catgut, skin muscles and fascia closed in layers with through and through silkworm gut tension stitches Several accessory spleens like medium-sized beans were left near cut end of pedicle Hypodermoclysis was given during operation

Following the operation she had a stormy convalescence with sharp temperature reaction, though the wound healed promptly The day following the operation she had a marked normoblastic crisis, the nucleated red cells numbering more than 25 for each white cell During the next six weeks she improved noticeably, the red cells rising to 4,100,000 and hæmoglobin to 40 per cent, the index remaining about 0.5 The white cells varied between 13,000 and 16,000 The nucleated red cells dropped in number rapidly

but rose again until upon her discharge on May 5, 1914, they numbered five times as many as the white cells. After leaving the hospital she continued to improve and when last seen February 6, 1916, she seemed well in every way and weighed eighty pounds. At that time the blood examination was red cells 4,600,000, hæmoglobin 65 per cent, color index 0.7, white cells 19,000, polymorphonuclears 31 per cent, nucleated red cells 138 for each 100 white cells, 2 of these being megaloblasts. The blood picture was essentially the same as upon her first admission to the hospital, except for the fact that the number of red cells and the hæmoglobin percentage were both increased.

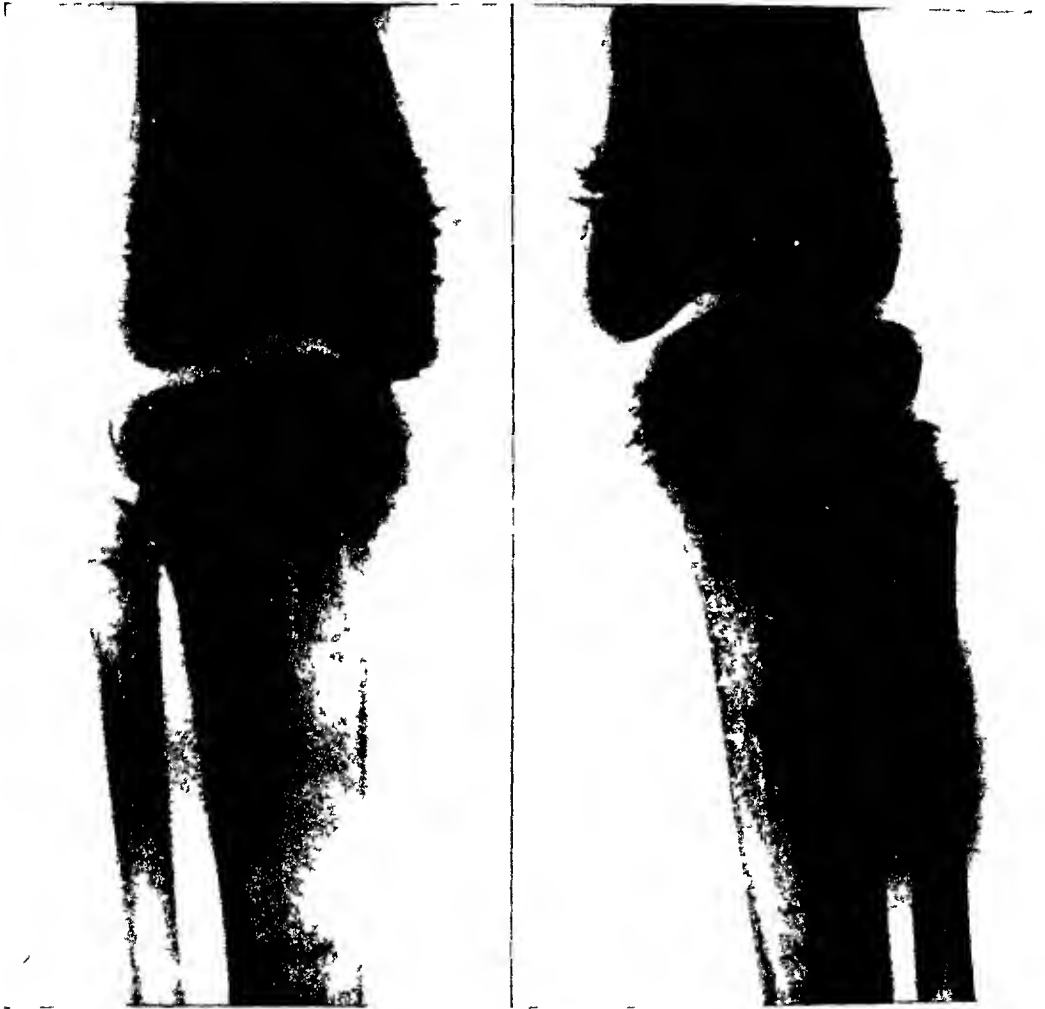


FIG 5—Upper end of tibia and fibula. Condition similar to Fig 1, but striations less pronounced.

Examination of stained blood smears after splenectomy by Doctor Stillman show an overwhelming predominance of nucleated red cells, about 28 nucleated red cells for every white cell seen. The nucleated red cells exhibit every type, there being a large number of megaloblasts and a few microblasts. The red cells as a whole are extremely irregular in shape and size, and stain very poorly. Many of the cells are very large and more or less laminated as if dragged out in the smearing and thus partly broken up. In some instances these large cells possess enormous pale hæmogenous nuclei and a few of these large nuclei are seen free on the slide. There is a moderate amount of basophilic degeneration and also a moderate amount of polychromatophilia. Many of these nucleated red cells show actively dividing nuclei. A differential count of 50 leucocytes revealed the following

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Polymorphonuclears—neutrophils 42, basophils 1, lymphocytes 6, myelocytes 1, nucleated reds 1420

Pathological Report—Splenomegaly with myeloidization (von Jaksch's anaemia)

Spleen is much enlarged but is of approximately natural shape and shows no extensive notching. Capsule is everywhere smooth and transparent. Spleen measures, after fixation in formalin, 20 cm in length, by 13 cm in maximum width, by 8 cm in thickness, weight (fresh) 1420 gms. On section the cut surface bulges considerably, is of a uniform dark brown color, smooth and shining and rather firm and leathery to touch. No trabeculae or lymph follicles can be distinguished, the color being quite uniform throughout.

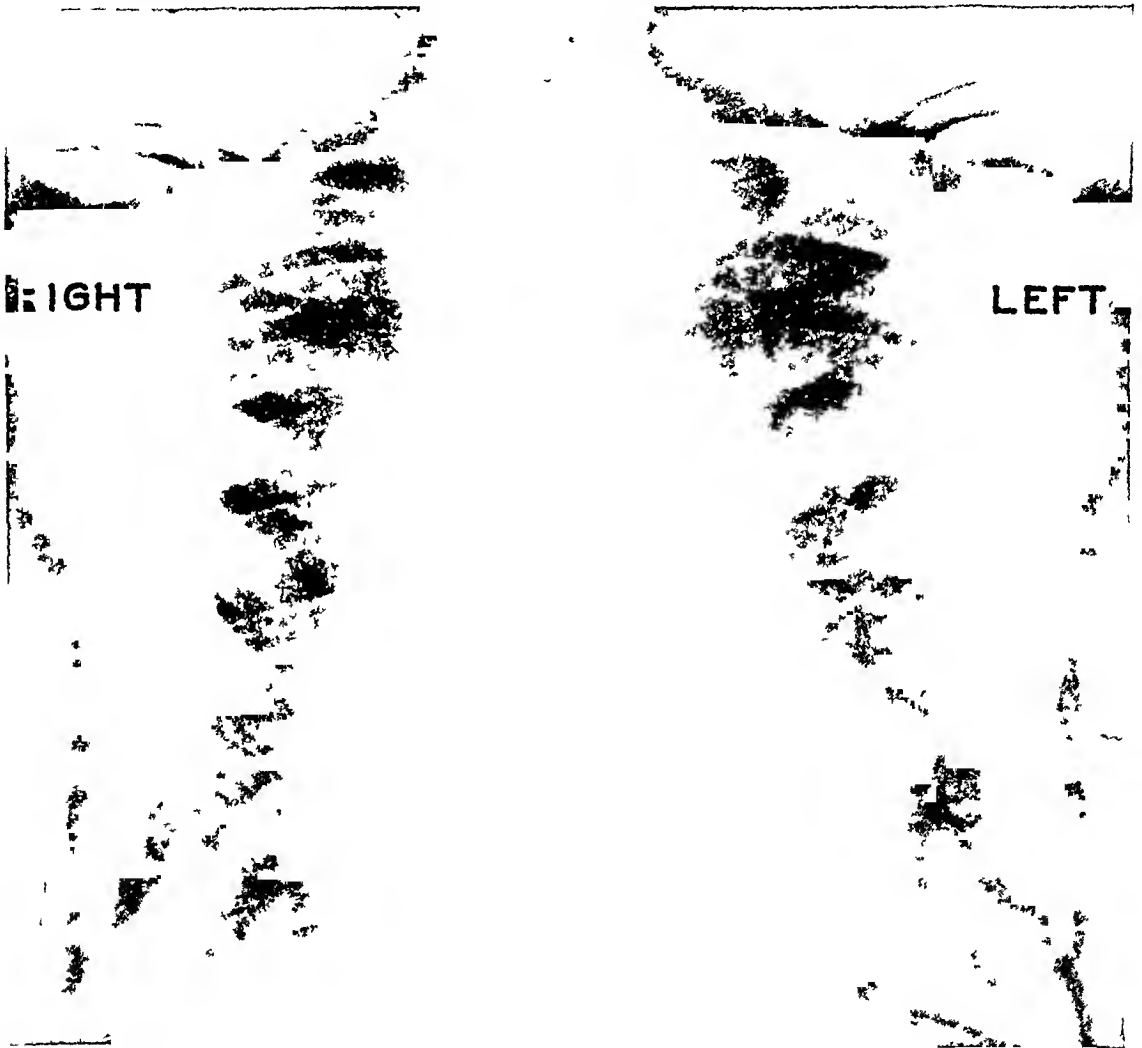


FIG 6—Chest. Note width of ribs and relatively large heart.

Microscopic sections show considerable congestion and considerable diffuse connective tissue increase, most extensive along the trabeculae, around the blood-vessels, and also occurring diffusely throughout the spleen tissue. Almost no lymph tissue is recognizable, only occasional small clumps of lymphocytes being seen and no structures resembling follicles are noted. Everywhere throughout the spleen tissue there are seen numerous collections of cells, with large oval or globular, pale staining vesicular nuclei mostly containing one or two prominent nucleoli. These cells have, for the most part, a scanty, ragged, granular cytoplasm but in intimate relation to these cells there are also seen other cells which are entirely similar in appearance save that the cytoplasm is filled with eosinophilic granules. Occasional similar cells are also seen with some small collections of deeply basophilic granules. All these cells, both from their general morphology and the fact that some of them contain eosinophiles or basophilic granules, must be considered

as myelocytes. They lie for the most part, in groups between or around the blood sinuses, but small numbers of similar cells are seen scattered among the blood cells in the sinuses. Small numbers of nucleated red blood cells are seen both with and without the sinuses. One large irregular giant cell was seen which had a deeply eosinophilic cytoplasm and five or six nuclei grouped at one end. The enlargement of the spleen and the destruction of the lymph tissue would seem to be due to the extensive production of myelocytes between the sinuses. The condition is essentially one of myeloidization and when the clinical course is taken into consideration, a diagnosis of von Jaksch's anaemia seems to be justified.

Patient has been under observation at yearly intervals. In 1925 she had a marked phlebitis of the veins of the right leg which subsided but left a little swelling. She was married in 1926 and in 1927 was delivered of a dead child at term. Following parturition she had a rather stormy time and her haemoglobin dropped but in December, 1927, it had returned to 45 per cent. Throughout the fourteen years she has been under observation the nucleated red cells have been present in larger numbers, ranging from 45,000 to 220,000 per c mm. Her condition is at present satisfactory and except for the anaemia and blood changes she has no physical signs that are other than normal. (See Chart, Case 1.)

CASE II—Alvaro B., age four, was admitted to the New York Hospital (Cornell Division), March 18, 1920, with the complaint that he looked yellow and pale, was weak and did not grow.

His present illness began two years ago when he became weak, complained of pain in his left side, did not eat and vomited occasionally. His abdomen gradually became swollen. No history of fever was obtained.

His past history was essentially negative. Child was full term and normally developed at birth and quite well up to two years of age when present illness began. Since then he has been weak and sick and does not eat or grow.

Family History—Father and mother are living and well. No history of syphilis. Two other children with same condition and two normal children.

Physical Examination—Child is pale with a curious tint to the skin. The sclerae are "steel blue", gums pale, lips look bloodless, teeth are poor, tonsils large and pathological, heart normal in size, systolic murmur over entire precordium not transmitted to the axilla, lungs were normal—no adventitious sounds. The abdomen was protruding, no fluid wave. On the left side extending from under the costal margin to the umbilicus and down to the crest of the ilium was a large smooth non-tender mass, no notch felt, lower edge not palpable. The extremities were normal. The child looked small and poorly developed for his age. There were no evidences of bone changes significant of rickets.

Blood—Haemoglobin 22 (Sahl), red blood cells 2,640,000, color index 0.4, white cells 8,850, differential—polymorphonuclears 46, lymphocytes 45, large mononuclears 6, eosinophiles 1, unclassified cells which look like bone marrow cells 2, frequent normoblasts and a few megaloblasts were found and were about 10 per cent of the nucleated cells counted. H_1 0.5, H_2 0.25, no iso-agglutination of blood, normal bleeding, and clotting time.

Blood Wassermann was negative in both antigens on April 10, 1920, and blood Wassermann of father and mother was negative in both antigens.

On April 16, 1920, Doctor Hitzrot did a splenectomy for splenomegaly.

Operation—Four inch left rectus incision splitting the rectus muscle. There was a small quantity of clear fluid in the abdomen. The spleen was quite movable but attached behind by a well developed lienorenal ligament. This was divided. The gastro-splenic omentum was then divided between ligatures and the pedicle of the spleen exposed. The pedicle was freed and ligated with two ligatures of heavy plain catgut, clamped on the splenic side and the spleen removed. There was one small adhesion at the

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CASE I
Margaret, Age 9

Date	Red cells	Hæmoglobin	Color index	White cells	Differential							Resistance to hypotonic salt	Nucleated red cells	Urobilin	Wassermann	Iso-agglutination
					Polys	Eosino- philes	Lymphos	Large Monos	Unclass	Mvelo- blasts						
April 1913	2 300 000	25	0.5	8 100	58	1	36	3.3	1.3		H 0.62 H ₂ O 44	4,300 Rare 220,000	+urine -blood	Neg	None	
March 1914 (before operation)	2 110 000	23		12 000	22		75	3				126 000 Average 140,000				
March 1914 (after operation)	2,400 000	30		14 000	20%		58%	10	12	Rare						
Nov, 1919	4,200 000	⁵⁵ (8.25 gr) (Date)	0.65	9,500	32	1.5	44	13	1.5	9		278,000	+urine			
Nov 1925	4 000 000	55			28.8	0.8	50.4	18.4	1.6	1.6		434 Rbc to 1 white				
Nov 1927	4,000,000	45%		9 700							H 64 H ₂ O 35	3 to 5 to 1 white 45,000				

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upper pole of the spleen on the diaphragm but this was separated without any difficulty After stopping the oozing, the abdomen was closed in layers using double loop silkworm tension stitches

NOTE Child's condition seemed about the same after the operation as it had been before

Pathological Report—Specimen consists of a spleen weighing 732 grams and measuring 6 x 12 x 22 cm The capsule is not thickened and there are no adhesions visible The color is normal The organ is somewhat increased in consistency The cut surface is dark red and Malpighian corpuscles are obscured Microscopical There is an increase in new connective tissue, not diffuse, but in strands, occurring around minute blood-vessels and as trabeculae The Malpighian corpuscles are not retained as such, but lymphocytes are numerous There is an increased blood content, and a very large quantity of brownish pigment granules Additional microscopic examination by Doctor Stillman shows reduction in the amount of lymphoid tissue due principally to reduction in the size of the follicles, many of which are poorly defined and represented by only an artery with thickened walls and a few lymphocytes surrounding it A few follicles are normal in size though poorly differentiated from the surrounding pulp There is an increase in connective tissue around the central artery and often an extension outward from this vessel The pulp contains few red blood cells The venous sinuses are compressed for the most part and there seems to be no great increase in connective tissue in the pulp There is an appearance of hyperplasia of the pulp cells though this may be due largely to the compression of the sinuses A few large mononuclear cells are seen in the pulp There is no increase in the pigment content

X-ray Examination—X-ray examination of the skull shows it to be of a very peculiar shape and the inner table is shown as a dense line The outer table shows the bone trabeculae at right angles to the inner table and hair-like in appearance The sella is very small and there is complete absence of the frontal sinus and the antra The ethmoids are developed fairly normally The sphenoids are very cloudy in appearance possibly due to a non-development The skull and the jaws look very much like ape-skull The thorax shows the cardiac shadow to be large with an unusual development of the ribs, they being very broad and heavy in appearance The hilus shadows are accentuated and the linear markings are very definitely increased throughout both lungs

The long bones show a marked decrease in the thickness of the cortex with curious transverse striations most marked in the lower ends of diaphysis The condition resembles that described by Cooley

Following the splenectomy the most striking immediate change was a marked normoblastic crisis in which the nucleated red cells rose to 102,000 per c mm The differential count of the nucleated cells showed

Normoblasts	356
Megaloblasts	58
Polymorphoneutroph	67
Lymphocytes	24
Large mononuclears	4
Bone marrow ? cells	6
	—
Cells counted	515

This blood picture persisted throughout the two succeeding months with nucleated red cells ranging from 100,000 to 125,720

His white cells averaged about 24,000 during this period with an average differential count of

UNCLASSIFIED TYPE OF SPLENOMEGALY IN CHILDREN

Polymorphonuclears	44.5
Eosinophiles	1.5
Basophiles	2.5
Mononuclears	20.5
Lymphocytes	22
Marrow and unclassified cells	9
	<hr style="width: 10%; margin: 0 auto;"/> 100.0

His urine contained a trace of urobilin on one examination which was absent in the others

He left the hospital in June, 1920, in good condition with an improving appetite

His second admission was August 27, 1920, when he entered to have his tonsils removed. This was done by Doctor Farr and large pathological tonsils containing a hæmolytic streptococcus on culture were removed.

From August to December the blood picture showed little or no change from the above. On December 4, 1920, his blood picture was as follows: red blood cells 2,028,000, Hæmoglobin 32, (Sahl) 35, (Dare). White blood cells 71,400, nucleated red cells 132,600.

Differential count: Polymorphonuclears 36, lymphocytes 42, large mononuclears 16, transitionals 3, eosinophiles 2, unclassified 1. Total 100.

In February, 1921, his blood showed 220,000 nucleated red cells with a blood picture similar to that described above.

In September, 1921, he was given a transfusion of 200 c.c. of blood by the syringe method. At this time his white cells were 26,000 and the nucleated red cells 260,000 with the remainder of the blood picture about as above.

In January, 1923, he was admitted for submaxillary abscess which was opened and drained. Culture—staphylococcus aureus. Transfusion 600 c.c. (Unger method) on January 24, 1923. Blood picture before transfusion: red blood cells 2,680,000, hæmoglobin 35 (Dare), white blood cells 12,000, nucleated red cells 168,000.

Differential count: Polymorphonuclears 70, lymphocytes 28, mononuclears 2.

After transfusion, two days, red blood cells 3,200,000, hæmoglobin 45, white blood cells 14,136, nucleated red cells 126,000.

Differential count: Polymorphonuclears 39, lymphocytes 22, mononuclears 2, eosinophiles 5, unclassified 32 (myelocytes(?) myeloblasts—curious mononuclear cells disintegrating).

This condition has persisted up to the last examination in January, 1928, when Doctor Stillman reports as follows:

January 23, 1928—Examination of a stained blood film shows the red cells to vary markedly in size, to a less extent in shape and extremely in staining. Practically all of the red cells that are not nucleated stain irregularly, not only showing pale centres but in many instances showing an irregularity of distribution as though the cell had swelled and was on the point of disintegration. Nucleated red cells, both normoblasts and megaloblasts are exceedingly numerous and are often quite highly polychromatophilic. Many of the red cells show basophilic stippling. One gains the impression that the average diameter of the red cells is somewhat less than normal. The white cells appear not to be increased though this is difficult to estimate since they make up less than twenty per cent. of the total nucleated cells. There appears to be a relative lymphocytosis but this is not certain since in all probability some of the cells counted as lymphocytes are actually erythroblasts. The differentiation between these two cells is not always easy when the staining is not exactly right. A few cells are seen which are perhaps to be considered myeloblasts though no myelocytes were found in counting 200 cells. A fair number of plasma cells were seen.

Erythroblasts number 67 plus in 50 fields with the oil objective, an average of $13\frac{1}{2}$ per field.

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Sixty-seven plus normoblasts and megaloblasts were counted while counting 127 white cells

The nucleated red cells are therefore $53 \times$ the white cells which are about 15 per cent of the nucleated cells

Differential count (200 white cells)

Polymorphoneut	32.5%
Eosinophiles	2.0%
Basophiles	0.5%
Lymphocytes	55.5%
Plasma cells	2.0%
Large mononuclears	6.0%
Myeloblasts (?)	1.5%
	<hr/>
	100.0%

The blood picture indicates of course tremendous stimulation of the erythroblastic tissue, apparently without corresponding activity of the leukoblastic cells. The platelets again are increased and appear so in the film. There is also apparently increased destruction of the red cells as indicated by the color of the patient and his rapid drop in red cells after transfusion, but also by the appearance of many of the cells in the film. This case is very similar to that of Margaret M. (Case I) in its reaction and persistence of the erythroblastosis and in color.

No accepted diagnosis can be suggested.

(See Chart, Case II.)

CASE III—Armando B., age two years and eight months, was admitted to the New York Hospital, March 18, 1920, with the complaint that he looked yellow and had a pain in his left side.

His present illness began about one year ago when mother noticed peculiar yellow tint to child's skin, attack began with vomiting two or three times daily and during the past week has had a discharge from the left ear.

Past history essentially negative, no diseases.

Family History—Full term child, no trouble with birth, two other children in family with similar trouble (Case 2 and 4). Father and mother living and well, blood Wassermann negative for both parents.

Physical Examination—A marasmic child, pale, sclerae blue, lips anæmic. Heart and lungs negative. Large mass extending from rib margin on left side to mid-line at navel and down almost to crest of ilium, definite notch felt, liver not palpable.

Blood Picture—Hæmoglobin 30 per cent, red blood cells 3,328,000, white blood cells 19,300, polymorphonuclears 59, lymphocytes 33, mononuclears 8, marked changes in size and shape in red cells, a few scattered nucleated red cells found, no megaloblasts.

Fragility test

H ₁ — 6%	H ₁ — 55	H ₁ — 45	H — 45
H ₂ — 3%	H ₂ — 4	H ₂ — 3	H ₂ —not complete at 25

Wassermann negative, stools contained urobilin. Some resistance to hemolysis of red cell, no iso-agglutination.

Anæmia increased and blood picture on April 10, 1920, shows Hæmoglobin 18 per cent, red blood cells 2,992,000. Marked poikilocytosis, anisocytosis and polychromatophilia, individual cells pale and many different sizes, numerous normoblasts and megaloblasts.

Blood picture taken on May 5, 1920, before splenectomy shows Red blood cells 3,528,000, white blood cells 34,594, nucleated cells 51,200, polymorphonuclears 52, lymphocytes 24, mononuclears 14, eosinophiles 4 per cent, basophiles 2, bone marrow 4 per cent.

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CASE II Alvaro Bellua, Age 4

Date	Red cells	Hæmoglobin	Color index	White cells	Differential							Nucleated red cells	Resistance to hypotonic salt	Urobilin	Wassermann	Iso agglutination
					Polys	Eosino- philes	Lymphos	Large Monos	Unclass	Myelo- blasts						
March, 1920	2,640,000	Sahl 22 (Dare) 16	0.4	8,850	46	1	45	6	2		Frequent	H ₁ 0.5 H ₂ 0.25 H ₃ 0.25	Urine Neg	Neg	None	
April 1920 (after operation)	3,608,000			20,400	67		24	4		5	102,000		Urine +			
May 1920											100,000					
June, 1920	2,840,000	32		24,680	44.5	1.5	22	20.5	2.5	9	125,720 (1.5% Megakloblasts)		Urine Neg			
Nov 1920											132,600		Urine Neg			
Transfusion Feb., 1921											220,000		Blood Neg			
Sept., 1921											260,000					
Jan., 1923 Transfusion	2,680,000 3,200,000	35 45		12,000 14,136	70 39	5	28 22	2 2		31	168,000 126,000					
1927	3,900,000	40		6,500	49	1	47	3			124,500					
Octo 1927											5 to 1 white					
Transfusion Jan 1928	2,950,000	28		5,000	32	2	55.5	6	2	1.5	5.3 to 1 white					

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Blood picture after splenectomy shows Hæmoglobin 44 per cent, red blood cells 5,576,000, nucleated cells 70,400, white blood cells 18,975, nucleated red cells 51,425 About equal number of normoblasts and megaloblasts

Blood picture June 3, 1920, shows Hæmoglobin 35 per cent, red blood cells 3,496,000, nucleated cells 192,000, white blood cells 156, normoblasts 815, megaloblasts 29

Splenectomy—May 5, 1920 (Doctor Hitzrot), 300 c.c. of blood were given from donor by citrate method While the blood was being transfused the operation proceeded Four inch left rectus incision splitting the muscle The spleen was quite freely movable and was easily delivered After ligation of the vessels in the gastro-splenic omentum they were divided and the pedicle of the spleen exposed The tail of the pancreas lay in the hilum of the spleen and had to be liberated before the vessels could be ligated There were three small accessory spleens (hemo-lymph glands) on the vein about 1 cm. from the ligature The vessels were doubly ligated and the spleen removed The liver was normal in appearance no pathological changes and not large The abdomen was closed in layers without drainage, using silkworm gut tension stitches

Pathological Report—Specimen consists of a spleen weighing 490 grams It is enlarged equally in all directions The capsule is smooth and not thickened or adherent The consistency is firm The cut surface is dark red and the markings are indistinct Microscopical—The sections show a reduction in the number and size of the Malpighian corpuscles and a hyperplasia of the spleen There are some strands of new connective tissue Additional microscopical examination by Doctor Stillman shows reduction in the amount of lymphoid tissue due to reduction in both the size and the number of follicles The follicles are small and poorly defined though they frequently contain germinal centres The walls of the central arteries are not thickened There is little increase in the amount of connective tissue The pulp contains few red blood cells The venous sinuses are compressed and there is a moderate amount of hyperplasia of large polygonal mononuclear cells There is no increase in pigment content To a certain extent the changes seen in this section resemble those seen in the spleen removed from the brother of this patient (Case 2) except that the walls of the central arteries of the follicles are not thickened, there is less lymphoid tissue, there are germinal centres present and there is much less increase of connective tissue in the pulp though more cellular hyperplasia One gets the impression that the two spleens represent different stages of the same process

Patient was readmitted on August 27, 1920, in about the same condition as he was upon discharge Blood picture at this time shows Nucleated cells 144,800, normoblasts 70 per cent, megaloblasts 12 per cent, polymorphonuclears 5 per cent, lymphocytes, etc., 13 per cent He was sent to the country on September 3, 1920, and readmitted to the hospital November 26, 1920 Patient has had chicken-pox during the interval Tonsils large and pathological, removed by Doctor Farr, Dec. 10, 1920 On December 22, 1920, a transfusion was given of 150 c.c.

Throughout this period nucleated red cells persisted, 86,000 per c.mm. to 120,000 and many abnormal white cells, myelocytes, megaloblasts and other irregular forms Urobilin in urine

Patient readmitted March 21, 1921, and a transfusion given on March 31st of 240 c.c., during this time nucleated red cells persists

Patient readmitted October 18, 1921, and since last admission has developed into healthy looking child, has been very well until the day before admission when he had a fever and became listless Ears have been discharging, temperature 103 degrees Blood picture Hæmoglobin 35 per cent, red blood cells 2,320,000, nucleated reds 80 per cent of nucleated cells Red cells in varying shapes and sizes and many of distorted forms

Transfusion of 275 c.c. given on November 3rd, and patient discharged on November 9

Readmitted on December 9, 1921—During the interval patient's ears have discharged intermittently but he has been well otherwise and active Two days before admission

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CASE III
Arnando Bellua, Age 2

Date	Red cells	Hæmoglobin	Color index	White cells	Differential						Nucleated red cells	Resistance to hypotonic salt	Urobilin	Wassermann	Iso agglutination
					Polys	Eosino-philes	Lymphos	Large Monos	Unclass	Myelo-blasts					
March, 1920	3 328 000	30		19 300	59		33	8			Occasional	H ₂ 06 H ₃ 03	Urine Neg	Neg	None
May, 1920 After splenectomy and transfusion	5 576,000	44		18,975							51 425		Urine +		
Aug, 1920	3 496 000	35		25 000	52		24	14	2	4	12% Megakloblasts 118 000				
Oct, 1921	2 320 000	35				4					150 000				
Died Acute Meningitis															

CASE IV
Victoria Bellua, Age 14

Date	Red cells	Hæmoglobin	Color index	White cells	Differential							Nucleated red cells	Resistance to hypotonic salt	Urobilin	Wassermann	Iso agglutination
					Polys	Eosino- philes	Lymphos	Large Monos	Unclass	Myelo- blasts						
June 1922 (before operation)	3 200 000	35		9 400	52	3	32	10	3		0		Urine Neg	Neg	None	
July, 1922 (after operation)	3,400,000	40		20 000	64	1	28	5	2	0	60 000		Urine Neg			
1923	3 856 000	45		20 000	45	6	30	15		4	23 000					
1927		50									35 000					
											40 000					

patient had fever and pain in his head, was very fretful and restless. Patient was examined by Doctor Erskine, who operated for acute mastoiditis of right ear and found infected mastoid cells and antrum (*Streptococcus hemolyticus*). During convalescence patient contracted measles and was sent to Willard Parker Hospital.

Patient was readmitted on January 27, 1922, with the history that he had been perfectly well until two days before admission, when he had become acutely ill, had a high fever and vomiting. Patient had all the signs of an acute meningitis with stiff neck, Kernig's sign, etc. Child grew rapidly worse and died of meningitis three days after onset of disease and about eighteen hours after entering hospital.

CASE IV—Victoria B, age fourteen years, was admitted to the New York Hospital, June 27, 1922, with the history that since she was two years old she had had attacks of bloating and her skin had become yellow. She has vomited at times and been quite sick, while at other times the attacks have been milder. The present attack began about four days ago and she had felt weak and tired.

Family History—She has two brothers with a similar condition, Cases II and III. The history is unsatisfactory as it has been obtained from the girl who was in Italy with her grandparents when the trouble began. She thinks she has developed normally. Has not menstruated.

Physical Examination—Under-sized child with yellowish tint to skin, facies normal, sclerae bluish-white, looks anæmic, heart and lungs negative. Abdomen protuberant, spleen large, smooth and hard, extends down to level of umbilicus. No tenderness over spleen, liver edge readily felt one cm. below costal margin in axillary line. Temperature ranged from 98° to 100 on day of admission.

Blood Picture—Red blood cells 3,200,000, hæmoglobin 35, white blood cells 9,400, differential, polymorphonuclears 52, lymphocytes 32, mononuclears 6, transitionals 4, basophiles 3, eosinophiles 3. The red cells showed poikilocytosis, anisocytosis, polychromatophilia and irregularity in size.

Wassermann was negative in both antigens, urine negative for urobilin, trace of albumin, blood urea nitrogen 11.5.

Splenectomy—July 13, 1922, (Doctor Hitzrot)—Five inch left longitudinal incision splitting the muscle. The spleen was delivered easily, the only adhesions being some between the stomach and the spleen. These adhesions were divided between ligatures. The pedicle was ligated, ligating the arteries separately and compressing the spleen before ligation of the vein. The spleen was removed and the splenic fossa peritonealized by three interrupted plain catgut stitches. The gall-bladder was a little thick but was not pathological. The liver was soft, showed no evidence of any microscopical change. The other abdominal structures were normal. The appendix was not removed. The abdomen was closed in layers without drainage with double loop silkworm tension stitches.

Pathological Report—Specimen consists of a large spleen weighing 900 grams and measuring 20 x 12.5 x 7 cm. The spleen is uniformly enlarged and has preserved its normal shape with the exception of a rounded projection near one pole which measures 5 cm and is elevated about 1.5 cm above the neighboring structures. This appearance suggests the existence of a tumor-like process in the spleen. The capsule is somewhat wrinkled which suggests that a certain amount of exsanguination of the organ has occurred following its removal and that the projection of the area referred to may be occasioned by the shrinkage of the rest of the spleen without corresponding reduction in the size of the tumefied area. This further suggests that the blood in the tumor-like portion of the specimen is not fluid and so does not escape readily. The organ is grayish-blue, its capsule slightly thickened and its consistence fairly firm, somewhat leathery. Cut section presents a beefy red, finely granular surface. The stroma is not particularly prominent. Malpighian bodies are fairly numerous and slightly enlarged. In one pole of the organ, corresponding to the protuberance referred to above, there is a globular, sharply circumscribed tumor-like mass measuring 5 cm in diameter. It appears to be surrounded by a very thin capsule and differs in structure from the remainder of the organ. It pre-

UNCLASSIFIED TYPE OF SPLENOMEGALY IN CHILDREN

sents a perfectly smooth surface on section and reveals little evidence of structure. It is dark red, shows no evidence of the presence of stroma or of structures resembling Malpighian bodies. It is traversed in places by a fine net-work which is dark red in color and here and there trabeculae of very delicate connective tissue bands are noted. The vessels supplying the spleen show no gross lesions. Microscopical examination based upon the study of material fixed in formalin, Muller-formol, Zenker and bichloride and stained with hæmatoxylin-eosin, von Gieson and Mallory's aniline blue.

Sections made from the spleen proper. The Malpighian bodies for the most part appear normal though a few show some evidence of compression and a lack of sharp differentiation from the pulp and occasionally one sees some central hyaline degeneration. The walls of the central arteries are apparently not thickened. Germinal centres are present in a fair percentage of the follicles. In the pulp, the venous sinuses are slightly dilated and there is an irregular distribution of areas of congestion. There is no definite hyperplasia of pulp cells and no increase in pigment. In the pulp one finds here and there mononuclear cells with acidophilic cytoplasm, usually located within the sinuses. The nucleus is round and the cytoplasm has a finely granular appearance. These cells are probably myelocytes and are found singly, not in groups. The appearance is not that usually found in so-called myeloidization. There is no increase in the amount of phagocytes of red cells above that found in the normal spleen. The capsule and trabeculae are not thickened. There is some increase in connective tissue in isolated areas in the pulp.

Sections made from the tumefied portion. At first glance these sections have no resemblance to normal splenic structure. There are no Malpighian bodies. The general appearance is that of small islands of cells showing very few erythrocytes surrounded by bands of tissue which is markedly congested and contains relatively few nucleated cells. On closer study there appears to be a suggestion of the presence of sinus structure or at least of channels without definite cellular walls though this may be merely an arrangement of the reticulum. The reticulum fibres are more abundant in the congested portion of the tissue and outline the cellular islands giving off to them delicate fibrils. The cells in these islands present nothing especially characteristic. They resemble splenocytes though vary greatly in size and show moderate anaplasia. Here and there are seen a few very large cells with eosinophilic cytoplasm having a slightly granular appearance and from two to eight large nuclei. There is no necrosis. The blood in the so-called congested areas has all the appearance of being stagnant and altered. This confirms the suspicion referred to above, that failure of this portion of the organ to shrink is due to lack of fluidity of the blood contained in it.

The tumefied portion of the spleen represents the results of interference with the circulation, probably due to thrombosis of a vessel. This feature, which differentiates this spleen from those removed from two other members of the same family, is without special significance. The structural changes in the spleen are relatively slight and are not characteristic of any definite clinical condition.

The child made an uneventful recovery although the temperature rose to 103 for two days after the operation. The hæmoglobin fell to 15 per cent and a large number of normoblasts and megaloblasts appeared in the smear. She was given two transfusions of 500 c.c. each, both of which raised her hæmoglobin to 35 per cent and 55 per cent, but in two days the hæmoglobin had fallen to 30 per cent showing an active hemolysis of the introduced blood. This condition continued until January 18, 1923, when she was again transfused and hæmoglobin brought to 55 per cent, red blood cells 3,920,000, nucleated cells 20,150 of which 20 per cent were nucleated red cells among which were many megaloblasts. Her last blood examinations in 1927 still showed 35,000 to 40,000 nucleated red cells although her general condition had improved and she looked better although there was still an evident anæmia (Hæmoglobin 50 per cent).

X-ray pictures of the skull and long bones showed no gross changes although the cortex was thinner than normal in the long bones.

ATYPICAL HÆMOLYTIC ANEMIA WITH SPLENOMEGALY IN CHILDREN

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AND

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IN THE study of the splenomegalies associated with the anemias, one is impressed with the difficulty of placing individual cases in the well-known groups or classifications. Especially is this true in those occurring in children. The one common factor in all these lesions is apparently the dysfunction of the reticulo-endothelial cells. In some, the abnormal reticulo-endothelial cells would seem to be concentrated in the spleen, for splenectomy in such lesions as typical chronic hæmolytic icterus permanently cures the disease and restores the patient to a normal state of health. In others, such as thrombopenic purpura, the dysfunction of the reticulo-endothelial cells may be limited to the spleen, but later even after splenectomy the dysfunction of these cells in other organs like the liver, lymph-nodes or bones, may reappear with fulminating hemorrhages. In still another group, the so-called Gaucher type of splenomegaly, the abnormal cells are present not only in the spleen—where they are most numerous, but are to be found in the liver, the lymph-nodes and the bone marrow¹. The variation in the type and degree of dysfunction of the reticulo-endothelial cells may well account for the many cases of splenomegaly associated with anemia and jaundice that do not fall into the well recognized groups.

In 1925, Cooley and Lee² of Detroit first reported a group of five cases of splenomegaly with anemia and jaundice that differed from the hæmolytic jaundice or the Von Jaksch's anemia seen in children. In September, 1927, Cooley, Witwer and Lee³ reported two more cases. One of these seven cases had had the spleen removed without definite improvement. In March, 1927, one of us performed a splenectomy on a child in whom the diagnosis of atypical hæmolytic jaundice had been made. Certain striking bone changes as seen in the roentgenograms, and atypical cells in the spleen resembling Gaucher cells were convincing evidence that we were dealing with an unusual variety of splenomegaly. In studying the literature we did not find any references to this type until we read Cooley's report of five cases.

Because a discussion of this type of splenic anemia or hæmolytic icterus has not appeared in the surgical literature, so far as we have been able to discover, we are presenting the case histories and findings in two sisters with these lesions on whom splenectomy has been done.

Whether these nine collected cases can be grouped as a clinical entity is open to question, but they present certain striking similarities which should arrest the attention of those dealing with splenomegalies in children. Thus

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far no such cases have been observed in the adolescent or adult periods. Of these nine cases, three died of the disease and were autopsied, three have been observed under conservative therapy consisting of diet, transfusion and tonics, one with improvement for a period of thirty months. Three have had splenectomy, one without improvement nine months after operation. One of our two cases has been observed fourteen months after splenectomy with improvement as regards nutrition, anemia and growth, but with an occasional exacerbation of jaundice. The other one of our cases has not been observed for a long enough period to state the effect of splenectomy.

The following features of the disease have been noted in all nine of the known cases

- 1 The onset is in infancy. Usually shortly after weaning the failure of the child to gain has attracted the mother's attention, to either the anemia, the jaundice or the enlarged abdomen.
- 2 All nine children have had an enlarged spleen.
- 3 All have had a profound anemia due to red cell destruction and the majority an appreciable but irregular acholic jaundice, without an increase in red cell fragility.
- 4 All have shown evidence of a striking overstimulation of the bone marrow as shown by the immature red cell forms.

Because of these factors certain striking physical signs, roentgenographic findings and laboratory data are present and help to group these cases

- 1 The facies. Two points are striking. The muddy jaundiced color varying with the amount of hæmolysis and the Mongolian features, due to the thickening of the cranial bones especially the frontal, the malar and the parietal bones.
- 2 The roentgenograms. The films of the skull show marked thinning of the inner and outer tables with very great thickening of the diploe especially in the frontal and occipital bones. The films of the long bones show a lack of calcification except for transverse lines of calcium giving a streaky appearance.

The marked hæmolysis is evidenced by the low hæmoglobin, the low red cell count, the great excretion of urobilin in the stools and the icteric tinge of scleræ and skin.

The overstimulation of the bone marrow is shown in the hyperplasia of the cancellous bone, particularly in the diploe of the skull causing the roentgenographic picture, and in the enormous numbers of normoblasts and reticulated red cells. In none of the blood smears or in the post-mortem studies has there been evidence of leukemia. There has been a leucocytosis in several of the cases suggestive of the Von Jaksch's anemia.

As regards the bone changes seen in the roentgenograms, Cooley states that these changes are the result of the reaction of the bone marrow to prolonged overstimulation as a result of chronic hæmolysis, beginning before the cortex is strong enough to limit the overgrowth of bone marrow. In examining a number of films of these cases, there seems to be a definite pathological entity, in that these bone changes are very similar in each instance. These changes apparently begin very early. As the chronic hæmolytic process advances the marrow hyperplasia increases at the expense of the cortex which

becomes markedly thinned and decalcified. In the bones of the skull, for instance, the cortex is expanded, especially in the parietal and frontal regions. The outer table of the skull expands giving the children a Mongolian appearance. This finding seems to be fairly consistent. The long bones in these cases show this marked decalcification, marked thinning of the cortex and numerous lines of increased density. These lines generally run transversely through the shaft. We are at a loss to explain these changes which are present in the early stages of the process. It indicates a replacement of exhausted marrow by new bone but just why it should be laid down in this thin transverse layer, and in the early stages, we have not yet fully determined. In one case observed by Grulee and Cooley, the diagnosis of sickle-celled anemia was fairly well established and in this the case of above bone changes were noted. Gansslen⁴ described certain constitutional markings in cases of hæmolytic icterus but so far as we were able to determine no Rontgen studies similar to those recorded here were noted. In earlier stages and in less severe cases, the porous appearance in the rontgenograms seems to represent marrow hyperplasia, while in the terminal stages the pronounced striation indicates replacement of exhausted marrow by new bone as seen in the autopsied cases. The studies of the blood calcium and blood phosphorous in Cooley's cases and in one of our patients does not throw any definite light on the cause of the bone changes. The variations in these blood elements are not controlled by splenectomy.

The study of the spleens removed at operation or autopsy show a marked increase in the fibrous tissue of the capsule and trabeculæ. In the two spleens which we removed special stains were used which bring out more clearly the architecture and the cell structure. Dr. Stout's report is as follows:

Microscopic—"Sections of the spleen have been stained with Masson's Ponceau, aniline blue, acid fuchsin and iron hæmatoxylin, with Masson's metanil yellow, acid fuchsin and iron hæmatoxylin and with Scharlach R. The only lesions noted are a mild degree of fibrosis which is generalized and the presence at scattered intervals in the splenic pulp of rather large cells with eccentric nucleus and with the cytoplasm vacuolated. The material in the vacuoles does not stain with Scharlach R which rules out the lipid bodies. It stains a faint delicate blue with the aniline blue and a very pale yellow with the metanil yellow.

"The splenic corpuscles are rather widely separated and the pulp has little blood in it so that the spongy sinuses are easily made out. They contain no unusual type of blood cell. There has not been time to have the spleen analyzed to determine the presence or absence of the cerebroside kerosin, the material which is found in the large cells of Gaucher's disease. The picture in this spleen is identical with that seen in the spleen of this patient's sister (Marie). Whether these scattered cells mean a mild Gaucher's disease or not, I cannot say because I do not believe that the early lesions of the spleen in Gaucher's disease have ever been observed. I have never seen these cells with vacuoles in any other spleen except those of Gaucher's disease."

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Inasmuch as sections taken from other typical chronic hæmolytic icterus spleens, and from other splenomegalies in the laboratory fail to show any such cells except in the three Gaucher spleens in our collection, the question arises as to whether these two cases are related to early Gaucher lesions. They are probably not early Gaucher cases, but the cells which resemble the Gaucher type are probably atypical or abnormal reticulo-endothelial cells. Many pathologists consider the Gaucher cell a form of abnormal reticulo-endothelial cell.

Only five-and ten-year follow-up results will determine the value of splenectomy in this group of hæmolytic anemias. We have not as yet seen any striking improvement in our two cases, comparable to splenectomy in chronic hæmolytic icterus.

CASE HISTORIES

CASE I.—A seven-year-old Italian girl was admitted to the Presbyterian Hospital, New York City, for enlarged liver, enlarged spleen and jaundice of two or three years' duration. Her family history was negative except that her sister, three years old, had been jaundiced for three or four months and had always been weak and refused her food. The brother was normal in every way.

The child had been weak since she was a year old. At birth the child weighed $8\frac{1}{2}$ pounds, following a very easy labor. She was breast fed $11\frac{1}{2}$ months, gaining well. Her infancy seemed quite normal in every way. At one year the child had measles. Following this she had pertussis for almost a year, which disease was complicated by a "capillary bronchitis" and an acute otitis media. Until a tonsillectomy at two years, the child had frequent sore throats. Always there had been occasional toothaches and many cavities.

When the patient was three years old she started to have attacks of jaundice for three or four days, recurring every three or four months, which would clear up with the use of cathartics and unknown medicines. In the interims her color was good.

When she was five years old, her brother was suspected of typhoid and the patient was examined at the same time. An enlarged spleen was discovered. During this period she was sick for a month and had a stiff neck and a fever as high as 105° , but no other details of her illness could be learned. About six weeks after her recovery from this acute episode, she was taken to Bellevue Hospital, New York City, where her diagnosis was recorded as familial hæmolytic jaundice. There she was noted to be acutely ill with a soft systolic murmur heard best in the third space to the left of the sternum, an easily palpable liver $3\frac{1}{2}$ cm. below the costal margin, a palpable spleen, a hæmoglobin of 55 per cent and a red blood cell count of 3,510,000. About three weeks later, the family refusing splenectomy, she was discharged against advice. At discharge, in spite of one transfusion, her hæmoglobin was 40 per cent, her red blood cell count 2,480,000.

For the ensuing two years her appetite became progressively less. Occasionally she had abdominal pain, or slight constipation. The bowel movements had not been observed. Dyspnœa was easily brought on, the patient having been carried upstairs to avoid it, and palpitation had become progressively more severe. There was no cough.

Except for nocturia once nightly and very dark urine—as dark as "coffee"—the genito-urinary symptoms were negative.

For the three weeks preceding admission she had been irritable, extremely weak and feverish, her temperature running to 103° .

Physical examination disclosed an almost moribund child of Mongolian appearance. There was noticeable dyspnœa, rapid and marked carotid pulsations and a yellowish tint to the skin. The scleræ seemed somewhat icteric. The mucous membranes of the lips and mouth and the tongue were very pallid. The heart was enlarged and presented a soft

apical systolic murmur and a soft early diastolic murmur heard well in the third and fourth spaces to the left of the sternum. The abdomen was markedly convex. The liver edge was felt at the level of the umbilicus and the spleen was about 3 cm below the costal margin. Both kidneys were palpable.

In the hospital, the child's initial blood findings revealed a hæmoglobin of 25 per cent, a red blood count of 1,670,000, and a platelet count of 100,000 per mm³. Her white blood cells numbered 6,100, with 29 per cent of polymorphonuclear neutrophils, 69 per cent lymphocytes and 2 per cent large mononuclears. The admission temperature was 100.6°, the pulse 130 and the respirations 32.

The blood Wassermann was negative. The clotting time was not increased, but the bleeding time was 6½ minutes as compared to one minute in the control. The fragility test was normal.

The child received eight weeks' treatment followed by splenectomy. The pre-operative therapy comprised ten transfusions of between 100 and 300 cc and daily doses of maltine with cod liver oil and an elixir of iron, quinine and strychnine phosphate. The hæmoglobin increased to 70 per cent and the red blood count to 4,140,000. Clinically there was marked improvement, the girl stating she felt better than she had "since she was a tiny baby." With improvement of the anemia, the diastolic cardiac murmur disappeared and the systolic murmur diminished and was mostly heard over the base. For several weeks her maximum daily temperature ranged to about 100.5°, gradually becoming normal. Three blood cultures were negative, one showed *Streptococcus Viridans*. The blood calcium was 9.05 mgs/100 cc, the blood phosphorus 5 mgs/100 cc. A second fragility was again normal. A reticulated count showed less than 1 per cent of these cells. Repeated blood smears were characterized by marked anisocytosis and poikilocytosis and, at first, marked acromia of the red blood cells, a few normoblasts and occasional to rather common diffuse basophilic cells. Over a period of four days, the average daily urobilin excretion in the stool was very high, namely 20,370 dilution units. On two occasions the urine contained a trace of urobilin, the foam test for bile was positive several times and negative several times. Gastric analysis was not done.

An X-ray of the lungs showed them to be clear. X-rays of the skull were featured by rather marked decalcification of all the bones, and rather marked widening of the diploe with numerous small areas of decalcification. In the films of the long bones, there was considerable decalcification of all the bones which was quite marked, leaving striated lines in places. The lower ends of the femora appeared somewhat flared out and wide for a child of this age.

Splenectomy was performed March 2, 1927, by Dr. Allen O. Whipple. At operation the liver was found enlarged and harder than normal. The spleen was about half again the size of a normal spleen, and was removed because of what was thought to be hæmolytic icterus.

Pathologically, the spleen was injected while warm with a warm neutral red solution and after half an hour sections of tissue were taken and prepared according to Gardner's technic. About two hours after this, smears were made from the scrapings of the pulp. These showed large numbers of phagocytic cells containing iron pigment. They also showed a few cells with granules of neutral red in the cytoplasm. The permanent sections failed to show any cells containing neutral red granules. Microscopically, sections from various parts of the spleen showed some increase in the number of collagen fibrils in some areas, showing there had been an irregular fibrosis. The splenic corpuscles were small and widely separated by the pulp. This showed widely dilated sinuses and venules. In view of the finding of so much phagocytic blood pigment from the fresh smear from the pulp, there was an astonishing absence of phagocytic cells with brown pigment in them in the stained sections. In some of the sinuses there were some very large mononuclear cells with a great deal of cytoplasm. In these cells, under oil immersion, were veinings with fine fibrils, reminiscent of the large cells of Gaucher's disease, but their numbers were relatively few. Inasmuch as there is no characteristic pathology of the

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spleen of hæmolytic jaundice, the patient's spleen was considered as maybe well representing that disease

The child remained in the hospital three weeks after the operation, recovering uneventfully. Two 24-hour urobilin determinations as the stool showed 10,880 and 6,400 dilution units respectively. At discharge the hæmoglobin was 70 per cent, the red blood cells 3,650,000

Since discharge from the hospital, fourteen months ago, the patient has been active and doing well at school. Her mother states that her color has varied from day to day, some days she is very jaundiced, other days almost rosy. Two weeks ago the hæmoglobin was 47 per cent and the red blood cells 3,400,000. Several previous blood counts, from time to time, gave approximately the same results. In the smears, there have been very numerous nucleated red blood cells. Further X-rays of the long bones have shown no change in appearance. Except for more thickening of the diploe, the skull X-rays are similar to those originally taken.

CASE II—A three-year-old Italian child was admitted to the Presbyterian Hospital, March 12, 1928, with a chief complaint of anemia, poor appetite, and inability to gain weight almost from birth.

The father and mother were living and well, though the mother gave a history of attacks of acute gall-bladder disease about the time of the birth of the oldest child. The patient's sister presented a condition similar to the patient, and had had a splenectomy one year before, following which she had improved though still anemic, occasionally feverish and showing yellowish discoloration of the eyes. No history of familial disease was otherwise obtainable.

The child was born at full term, after a normal delivery, and weighed 10½ pounds. No icterus was seen at birth. For ten or eleven months the infant was breast fed, but received orange juice at five months but no cod-liver oil until the second year. At the time of entry, a liberal diet was being supplied. At one year, the girl stood up, at seventeen months, she walked, at eighteen months she talked. Her first two teeth appeared at three months. At fourteen months, all the teeth had appeared.

Up to three months of age, the patient was perfectly well. Then she had two teeth, began to be feverish, and became very pale. Every three or four weeks she would have new teeth and each time feverishness, loss of appetite, and gradually increasing pallor would reappear. She showed yellowish discoloration of the eyes, first observed at about twelve months. At eighteen months, slowly progressive swelling of the abdomen began, and the urine became persistently a "sort of coffee-color."

Physical examination disclosed a chronically ill child of somewhat Mongolian facies. The mentality seemed normal. The skin was marked by a muddy palor and of an icteric quality. The hair was fine and dry. The eyes, ears and nose seemed negative. The lips and mucous membranes of the mouth were pale. The tonsils were moderately enlarged. The teeth were thin, unsubstantial looking and frequently carious. Slight coating showed on the tongue. The cervical lymph-nodes were palpable bilaterally as were the inguinals—others were not felt. The thorax, heart, and lungs were negative. The abdomen, however, was dome-shaped, very protuberant, and somewhat tense. The spleen projected downward 10 cm below the left costal margin and to the right just beyond the median line. The organ was hard, non-tender and smooth to the touch. The liver was likewise smooth, non-tender and hard extending 6 to 8 cm below the right costal margin. The reflexes showed equal and active knee-jerks and a positive bilateral Babinski. The circumference of the head was 49.5 cm, the chest at the nipple line 50.8 cm and the abdomen 51 cm. The temperature was 101.2°, the pulse 160 and the respirations 38. The weight was 26 pounds. The admission hæmoglobin was reduced to 35 per cent, the red blood cells to 3,500,000. The white blood cells numbered 29,100 with 42 per cent polymorphonuclear cells. There were 12 per cent reticulocytes. The smear showed marked anisocytosis and poikilocytosis, some acromia, and great numbers of nucleated red blood cells.

Previous to the patient's entry, she had been followed in the dispensary for several months. A fragility test was done which showed definite increase of fragility over the control cells but the exact record was lost. A reticulated count demonstrated about 15 per cent reticulocytes in 300 cells counted. The Wassermann was negative.

In the hospital, the child was given five transfusions of between 125 and 350 cc prior to splenectomy over a course of twelve weeks. This raised the hæmoglobin to 50 per cent and the red blood cells to 4,900,000. Her white blood count diminished, assuming an average of about 12,000 with 50 to 55 per cent polymorphonuclear predominance and no abnormal white blood cells. Another Wassermann showed a + reaction in both antigens. Three fragility tests were essentially normal as compared with the controls. Four reticulocyte counts gave 12, 3, 3 and 2 per cent reticulocytes respectively. A twenty-four-hour stool urobilin contained only 2,940 dilution units, but a twenty-four-hour urine urobilin contained 370 dilution units. On another occasion, no urobilin was detected in the urine. Fifteen urine examinations were done—on three occasions, there was a very faint trace of albumen. A few red cells were noted four times and a few white cells were usually seen. Gastric analysis was not done.

Stereoscopic views of the skull showed decalcification of all the bones of the skull and also those of the face. The inner tables of the frontal bones were increased in thickness, but the bone had a mottled spongy appearance. The jaw was markedly decalcified. Films taken five months later showed some increase in the bone porosity, with further widening of the diploe through the frontal bone. There was also some increased thickening through the parietal bone.

Films of both arms and legs indicated mild decalcification. The lower epiphyses of the femora appeared irregular about their margins, as if there had been some disturbance in their development. The lower ends of the femora and shafts of the tibiae were considerably wider than normal. Thinning of the cortex was slight and trabeculation appeared essentially normal, especially near the ends of the bones, in marked contrast to the patient's sister.

X-rays of the humeri, forearms, hands and ribs proved definitely abnormal. The humeri and the radii seemed larger than usual with distinctly coarsened and irregular trabeculation, thinning of the cortex, and generalized decalcification. These changes were least evidenced in the ulnae. The ribs maintained essentially the same changes. Comparisons with the X-rays of the sister were striking in the mutual similarity. Repetition after five months showed no change.

The hilum shadows of the lungs were moderately thickened on both sides, and a few small calcified nodes were present. In other respects the lung fields were negative.

The patient improved in strength and general well-being following her transfusions. April 9, 1928, splenectomy was performed by Dr Allen O Whipple. At operation he found the spleen about double normal size. The liver did not seem cirrhotic.

Following operation there was an unusual white blood cell response, the counts on the first and second days rising to 40,000 and 51,000 with polymorphonuclear neutrophils at 90 and 87 per cent, though the maximum temperatures were 101.4° and 102.2° only respectively. Ten days after operation the hæmoglobin was 45 per cent, the red blood cells 3,240,000, the white blood cells 20,000 and the polymorphonuclear cells 60 per cent. Nucleated reds numbered 45 to 100 red cells counted. The platelet count was at the high level of 570,000.

Two weeks post-operatively, the child was sitting in a chair, playful, feeling well, without pain.

The pathological report on the spleen stated

Gross—The specimen is a spleen which measures 12 × 6 × 8 cm. It seems to have lost a considerable amount of blood so that its measurements were probably much larger in the patient. There are some rather exaggerated notches in the free borders. The capsule is only thickened where the ragged threads of adhesions are attached to it and there are at least five main vessels entering the hylic surface scattered from one end to

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the other On section the splenic tissue seems very firm and the fibrous trabeculæ are easily distinguished The cut surface does not bulge but the many splenic corpuscles project forward like pallid millet seeds from the dull red background of the pulp Grossly the vessels appear normal No hemorrhages are seen

Microscopic—Sections of the spleen have been stained with Masson's Ponceau, aniline blue, acid fuchsin and iron hæmatoxylin, with Masson's metanil yellow, acid fuchsin and iron hæmatoxylin and with Scharlach R The only lesions noted are a mild degree of fibrosis which is generalized and the presence at scattered intervals in the splenic pulp of rather large cells with eccentric nucleus and with the cytoplasm vacuolated The material in the vacuoles does not stain with Scharlach R which rules out the lipid bodies It stains a faint delicate blue with the aniline blue and a very pale yellow with the metanil yellow

The splenic corpuseles are rather widely separated and the pulp has little blood in it so that the spongy sinuses are easily made out They contain no unusual type of blood cell There has not been time to have the spleen analyzed to determine the presence or absence of the cerebroside kersin, the material which is found in the large cells of Gaucher's disease The picture in this spleen is identical with that seen in the spleen of this patient's sister (Marie) Whether these scattered cells mean a mild Gaucher's disease or not I cannot say because I do not believe that the early lesions of the spleen in Gaucher's disease have ever been observed I have never seen these cells with vacuoles in any other spleen except those of Gaucher's disease

There is only a small amount of hæmosiderin scattered through the spleen

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SPLENECTOMY FOR TRAUMA

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TRAUMATIC rupture of the spleen is an extremely serious surgical condition that is not of infrequent occurrence. The reports by Berger,¹ Eisen-drath,² Bessel Hagen,³ Planson,⁴ Johnston,⁵ Barnes,⁶ and others who have diligently summarized and critically analyzed many of the case reports in the literature have served to show the necessity for operation in these cases. Except for that admirable chapter by Pool,⁷ in his monograph on "Surgery of the Spleen," no sufficiently adequate and authoritative treatment of this subject is to be found in our current text-books on surgery. Recently Bailey⁸ reported twenty-nine cases from the records of the London Hospital, and added three personal cases, which included all cases of traumatic rupture that entered the hospital during the thirty-three-year period, 1894 to 1926.

In 1921, I⁹ reported in detail six cases of traumatic rupture of the spleen and one case in which a splenectomy was performed for the spontaneous rupture of a normal spleen. In this paper we shall briefly outline our experiences with traumatic lesions of the spleen at Harlem Hospital, and draw therefrom conclusions that seem to be justified. This report is based upon the study of thirty-nine cases of splenic injury, and it includes all cases of traumatism of the spleen that entered the hospital during the twenty-three-year period, 1905 to 1927 inclusive. An operation or an autopsy proved the spleen to be the injured organ in all cases. There were thirty-two cases of traumatic subcutaneous rupture, one case of spleno-medullary leukemia and six cases of "open" wounds of the spleen.

Subcutaneous Rupture—The nature of the trauma varied, as indicated below:

Struck or run over by automobiles	18
Run over by a wagon	3
Falls	
from window	3
down elevator shaft	1
into area-way	1
from carriage seat	1
onto a pile of stones	1
Struck by a motorcycle	1
Struck by falling body of another person	1
Physical assault	1
No history of trauma	1
	—
	32

Automobile accidents produced the greatest number of these cases, and falls, of various kinds, were next in frequency as regards etiology. The

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frequency of splenic injuries has shown an increase in direct proportion to the increase in the use of the automobile. This is shown by the fact that in the twelve-year period, 1906 to 1916, there were twelve admissions to the hospital for ruptured spleen, and of these twelve cases, only three resulted from automobile accidents, while in the subsequent eleven-year period, 1917 to 1927, there were twenty admissions for splenic rupture and fourteen of these twenty cases were the result of automobile injury. The one case, in which no history of trauma could be obtained, was of interest from the standpoint of diagnosis. The patient presented all the signs of severe abdominal injury and showed an area of contusion in the left hypochondrium. It was ascertained that he had been drunk for three days preceding admission to the hospital. At operation a ruptured spleen was removed and the patient made an uneventful recovery. It is clear that this patient received some blow or fell injuring himself while under the influence of alcohol, and the only clue to the traumatic etiology in this case was the contusion to the abdominal wall, which in most instances is absent. The lack of history of trauma can occasionally obscure the diagnosis. The age incidence was as follows:

Age (years)	No. of cases
3	1
6	4
7	2
8	4
9	2
10	1
12	1
13	2
14	1
15	1
17	1
18	1
20	1
21	1
25	1
30	1
34	1
36	1
40	1
41	2
50	1
61	1

Twenty-two of the thirty-two cases occurred in persons under twenty-one years of age, eighteen cases occurred between the ages of six and fifteen years, showing that no age is exempt. Traumatic subcutaneous rupture occurs, however, most frequently in children, although the books on surgery of childhood by Barrington-Ward,¹⁰ Fraser,¹¹ and Campbell and Kerr¹² do not even mention its occurrence. Next in frequency it is found in those in the age period of adolescence. This age prevalence can be explained by

the inability of children to take proper care of themselves in the presence of danger and the recklessness of youth. Another factor is that milder degrees of trauma will produce rupture in children than in adults.

Sex Incidence—Twenty-five cases occurred in males and seven in females. The spirit of daring and adventure with consequent increased exposure to danger, on the part of boys as compared to girls explains the differences found in childhood, while occupational and industrial hazards explain most of the differences found among adults. Many early writers pointed out the protection afforded women by the use of corsets, which is becoming less and less applicable today, due to the change in style of feminine apparel.

In all cases, excepting one, the spleen, but for the traumatic lesion present, was normal on pathological examination, and in that one case a spleno-medullary leukemia was found. We cannot, therefore, agree with Archibald and Mayo¹³ when they state "that in accidents where the spleen is ruptured it will very often be found that a pathological condition existed previously and resulted in enlargement and friability of the organ." Enlarged diseased spleens are, of course, ruptured from milder degrees of trauma, but as regards the normal spleen we would, again, emphasize the fact that the physiological enlargement of the spleen following digestion is a probable factor in these cases of rupture. The traumatic lesion in most instances consisted of a large laceration which divided the organ into two parts. In some cases the laceration was stellate in character, and, occasionally the spleen was represented by a pulpy mass. Only one case showed a very small tear. In one case the splenic vein was also torn. No intracapsular tears were observed, although I did observe it in a case of spontaneous rupture. The abdomen was filled with blood and blood clots in all cases, the blood clots were chiefly around the spleen, and on the left side of the abdominal cavity, while free blood was found in the pelvis.

Seven cases in this series were not operated upon and all seven were fatal. The time period in the hospital and the necropsy findings are shown below.

Case No	Time in hospital before death	Post-mortem findings
1	4 hrs 15 min	Fractured skull, fractured ribs, ruptured spleen
2	11 days	Left lobar pneumonia, left pneumo-thorax, ruptured spleen
3	2 hrs 20 min	Ruptured spleen
4	2 hrs 50 min	Ruptured spleen
5	2 hrs 30 min	Fracture of 7th, 8th & 9th ribs, contusion of base of left lung, ruptured spleen
6	1 hr	Ruptured spleen
7	2 hrs	Spleno-medullary leukemia, ruptured spleen, left empyema

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Two of these patients refused operation and the case of spleno-medullary leukemia was seen in surgical consultation, in the medical ward too late to be saved by operation. The lack of operation in the four remaining cases, which occurred early in our experience, was due to errors in judgment, in that all of these patients were in extreme shock and the delays caused by our attempts to combat shock were fatal. We are confident that one or two of these cases might have been saved by immediate operation. We are more and more on the lookout for these cases now and their occurrence is becoming increasingly rare.

The frequency of associated lesions is indicated in the following table

Case No	Splenic and Associated Lesions	Result
1	Ruptured spleen	Cured
2	Ruptured spleen, laceration tail of pancreas	Died
3	Ruptured spleen, lacerated wound of greater curvature of stomach, retroperitoneal hemorrhage	Died
4	Ruptured spleen, perforation midportion of intestine	Died
5	Ruptured spleen	Died
6	Ruptured spleen, fracture 7th rib	Died
7	Ruptured spleen, lac rt lobe of liver, and injury to splenic vein	Died
8	Ruptured spleen	Cured
9	Ruptured spleen	Cured
10	Ruptured spleen	Cured
11	Ruptured spleen	Died
12	Ruptured spleen	Cured
13	Ruptured spleen	Died.
14	Ruptured spleen, small laceration of liver	Cured
15	Ruptured spleen	Cured
16	Ruptured spleen	Cured
17	Ruptured spleen	Cured
18	Ruptured spleen	Cured
19	Ruptured spleen, concussion with fracture of skull, traumatic synovitis, knee-joint	Died
20	Ruptured spleen	Died
21	Ruptured spleen	Cured
22	Ruptured spleen	Cured
23	Ruptured spleen	Cured
24	Ruptured spleen	Cured
25	Ruptured spleen	Cured

In eleven, or 29.1 per cent of our cases associated lesions were present, the frequency of its occurrence is somewhat less than that indicated by DaCosta,¹⁴ when he states that "traumatic rupture is rarely found unassociated with other injuries." Only four operative cases died where the pathology consisted of rupture of the spleen alone, while in the other six fatal cases there were injuries in addition to that of the spleen. On the other hand of the fifteen cured cases, only one presented an associated lesion and the lesion in that case in addition to the splenic injury was a small laceration of the liver. In only three of the non-operated cases was the spleen alone

injured. The presence or absence of associated lesions, have, in our opinion, a very distinct bearing on operative mortality. Prognosis is always worse when additional injuries are present, as ten of these eleven cases were fatal. Splenic rupture, in the absence of associated lesions, is not apparently, quite as serious a condition, as has been generally assumed.

The symptoms and signs of ruptured spleen are chiefly those of shock and hemorrhage. Marked variations in degree occurs in different cases, and no two cases are exactly alike. Many patients do not survive the initial shock, and in these cases of immediate death, hemorrhage is the causative factor. In many instances the diagnosis of rupture of the spleen is impossible before operation. The clinical picture presented is, obviously, that of a grave abdominal injury due to trauma. Pool points out the fact, that there is, in some cases, a distinct latent period between the subsidence of the signs of shock and the development of the signs and symptoms of internal hemorrhage. The recognition of this point will lessen mortality because if a patient is operated upon during this interim, before the evidences of internal hemorrhage are marked, the operative risk would be reduced in these particular cases. In this series three patients did not show any signs of hemorrhage for the twenty-four-hour period following admission, and of interest is the fact that these three patients showed a slight rise in temperature which we believe to be important as indicating the passing of the initial shock. Lejais¹⁵ records a case in which twenty-four days elapsed between the time of the injury and the development of profound symptoms, and Jackson¹⁶ reports a case in which twenty-eight days elapsed, and in both of these cases the signs and symptoms were those of intra-abdominal hemorrhage.

All our patients, excepting one, were conscious and rational upon admission. This one exception was semi-conscious as a result of skull fracture. In two cases a history of immediate but brief loss of consciousness following the injury was obtained. Robitshek¹⁷ in listing the symptoms found in 128 cases does not even mention it, while Bailey, who noted its occurrence in three consecutive cases, considers it of great diagnostic importance. Apparently it is only incidental.

All patients complained of abdominal pain. In most instances it was localized in the left hypochondrium, but in others it was generalized throughout the abdomen. In only one case was Kehr's sign, or pain in the left shoulder, present, and in this case the patient was injured the day preceding his admission to the hospital. He gave a history "of being unable to sleep the previous night because of a sharp, cramp-like pain in the left side of the abdomen, which was aggravated by breathing, but in the morning the pain moved to his left shoulder." Brogsitter¹⁸ thinks "that pain in the left shoulder is of little diagnostic importance, as it is seen in other instances of injury of abdominal organs, particularly of the left lobe of the liver." Abdominal pain is invariably the chief complaint of these patients.

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Vomiting occurred in seven cases, or 21.7 per cent pre-operatively, after admission. The vomitus was brownish or coffee-ground in color. Robitshek reports vomiting in thirty-five out of 120 cases, or 27.7 per cent. Bailey considers "the absence of vomiting a point of some diagnostic importance, in that it is against the chance of the case being one of ruptured spleen," and Melchior¹⁹ also thinks that vomiting is rare in splenic rupture. On the other hand, Trendelenburg²⁰ states "that vomiting is a guide as it is usually absent in cases of injury to the alimentary canal." It is our opinion, that vomiting occurs sufficiently frequent to be a symptom of some diagnostic value. In two cases, in this series, enemata provoked vomiting. Enemata pre-operatively are dangerous, in that they may give rise to a sudden marked and alarming increase in the hemorrhage where the existent hemorrhage is slight or delayed, as happened in several of our cases, and is beautifully illustrated in Doughtie's²¹ case, although apparently unrecognized by him. Because of the possibility of aggravating hemorrhage the giving of enemata before operation in cases of suspected ruptured spleen is definitely contraindicated. This holds true in all cases of suspected intra-abdominal injury.

Dulness on percussion in the left flank was found in sixteen cases and is a symptom of importance. Obliterated liver dulness was noted in three cases. Ballance's sign, or shifting dulness in the right flank, with fixed dulness in the left flank was observed in only one case.

Abdominal distention was present in all of our cases and is a symptom that must be duly considered.

Palpation has been a very valuable aid in these cases of suspected splenic rupture but it must be carefully applied. In eight of our cases we made a tentative diagnosis of splenic injury which was verified at operation. This feeling can best be described by comparing it to that found in the early stages of tuberculous peritonitis.

Abdominal rigidity was found in all our cases but we have to consider that the rigidity may be caused as much by the trauma to the abdominal wall which produces the injury as to the injury of the abdominal organ itself.

The admission temperature usually ranged from subnormal to 100 degrees, nine cases showed a temperature of 100 degrees and the highest temperature noted was 101.6 degrees. The average admission pulse was rapid and weak and at times was almost imperceptible. Generally the pulse rate varied between 120 and 140, while five cases showed a pulse rate of less than ninety-four. The admission respiratory rate varied between twenty and fifty, the average was twenty-four to thirty. The admission temperature, pulse rate and respiratory rate findings are presented only to illustrate the usual variations found. A careful study of the pulse is essential, and its diagnostic and prognostic value cannot be overestimated. The symptoms and signs of shock and internal hemorrhage are too well known to warrant further comment.

Ten cases showed external evidences of bodily injury, and they were as follows:

Abrasion of the scalp	1
Laceration of the scalp	1
Subcutaneous emphysema due to fractured ribs	2
Contusion of left hypochondrium	1
Fractured femur	1
Contusion of left orbital region	1
Contusion of back	1
Abrasion of ribs at level of ensiform	1

Only three cases showed any external marks on the abdomen or back. Twenty-two cases in this series presented no visible marks of injury on their bodies, and it is our opinion that in these cases the force is transmitted through the abdominal muscles, while they are relaxed, and the internal organs receive the full brunt of the violence. A large hæmatoma or contusion of the belly wall is produced by the action of the force against taut abdominal muscles, and, according to our experience, there is usually no visceral injuries, as the force spends itself against the abdominal wall. This applies to all cases due to trauma, where considerations of possible internal injury enter. The absence of external marks on the abdomen has been noted by numerous observers, but its importance as regards diagnosis, has been rarely or never stressed. Following a history of severe trauma in a case showing abdominal symptoms the absence of marks on the body is a point that is greatly in favor of internal injuries of a grave nature, as most cases of traumatic rupture of a viscus do not present body marks.

The admission blood examinations showed the usual changes attributable to hemorrhage, namely a varying leucocytosis, with a constant increase in the polymorphonuclear leucocytes, and a variable but almost constant and corresponding decrease in the hæmoglobin estimate and the red blood count. The white blood counts ranged between 9,000 to 48,000 white blood cells, and averaged between 12,000 to 18,000 white cells, and the polynucleosis, which varied between 72 per cent to 90 per cent of polymorphonuclear cells, averaged between 80 and 85 per cent. The red blood count was practically always decreased, and the average was between 3,000,000 and 3,500,000 red blood cells, while the highest and lowest counts observed were, 4,900,000 red blood cells and 2,700,000 red blood cells, respectively. In every case but one, there was a corresponding decrease in the hæmoglobin estimation, and the average was between 60 and 70 per cent. The highest hæmoglobin estimate noted was 95 per cent and in this case the red cell count was 4,900,000, and the white blood count was 16,000 leucocytes, with 84 per cent polymorphonuclear leucocytes. The blood findings indicate in general concealed hemorrhage, and from that point of view, they are of important diagnostic value. The work of Cannon,²² must however be kept in mind, as he showed that in severe traumatic shock without hemorrhage as a complicating factor, the capillary red blood count may be very high, and may amount to 6,000,000 red blood corpuscles, while the venous count is always lower. Hemorrhage always reduces the high capillary count.

In three cases the urine examination showed gross and microscopic

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blood and these three cases were fatal. Autopsy showed a laceration of the left kidney. There were no other urinary findings of significance.

A pre-operative diagnosis of ruptured spleen was made in eight cases, six cases were diagnosed as rupture of the intestines, and in the remaining cases the diagnosis was intra-abdominal injury with hemorrhage.

The treatment of splenic rupture is immediate operation in all cases, and splenectomy is the operation of choice. Twenty-five patients were operated upon, with fifteen recoveries and ten deaths which makes our operative mortality 40 per cent. This is higher than the published operative mortality of most observers, and most comparative studies of published mortality statistics in these cases give but an imperfect representation of the actual conditions. The reason for this is, that there are many factors involved, which in themselves vary in degree and extent, such as the nature and degree of the trauma, the extent of the pathological lesion, the degree of the hemorrhage, the presence or absence of associated lesions, the time elapsing between injury and operation and also the usual tendency on the part of observers to report more often operative recoveries than operative deaths. Many studies of each factor separately, and in a detailed way are needed, and based on these findings, a scientific grouping should be made, and from a study of a large number of properly classified cases, it will be possible to draw sound conclusions. To delay operation or to palliate is to invite disaster. Spontaneous recovery has been reported, but in the light of our present knowledge the chances of such are practically nil, and we are becoming increasingly more skeptical of its occurrence.

Splenectomy was the operation performed in twenty-four cases, and in one case a small tear was sutured. The one case in which a suture was used died, but death in this case was due to peritonitis. Lamarchia's case as cited by Moynihan,²³ illustrates an unusual possibility of danger in these cases where suture of the spleen is done, in this case a tear on the inner surface of the spleen was sutured, but death occurred from hemorrhage from an unnoticed wound on the posterior border.

Sprengel's incision was used in eight cases where a pre-operative diagnosis of ruptured spleen was made, because of the excellent exposure it affords, while in the remaining cases a left rectus incision was used. At times it was necessary to make a horizontal incision, to the left, and about the middle and at right angles to the vertical incision, but in no instance did it seem necessary to resect the costal border, as is done by Aueay.²⁴ Neither is the submammary incision and subperichondral section of Doyen,²⁵ or the transdiaphragmatic approach, that is so warmly advocated by de Tarnowsky²⁶ to be recommended, as, in our opinion, they unnecessarily prolong the operation.

Recovery has occurred following packing alone where the lesion was small and superficial. Gibbon,²⁷ in 1908, advocated "judicious packing" and stated "that any case that lives four to five days after rupture can be saved without splenectomy," which, of course, has been proven not to be the case.

That a rupture may be present, be overlooked at operation, and eventually cause death is shown by Lejars' case

A study of this material was made as to the effect on the outcome of the time in the hospital before operation, and also the time that elapsed after operation in the fatal cases

Case No	Time in hospital before operation	Hrs elapsing after operation in fatal cases	Result
1	6 hrs		Cured
2	6 hrs 15 min	4 hrs 10 min	Fatal
3	No record	died on table	Fatal
4	4 hrs	6 hrs	Fatal
5	2 hrs	6 hrs	Fatal
6	6 hrs 30 min		Cured
7	8 hrs	14 hrs 30 min	Fatal
8	50 min	1 hr 15 min	Fatal
9	6 hrs 40 min		Cured
10	6 hrs 40 min		Cured
11	4 hrs 20 min		Cured
12	3 hrs		Cured
13	1 hr 50 min		Cured
14	12 hrs 30 min		Cured
15	6 hrs		Cured
16	3 hrs		Cured
17	1 hr 50 min		Cured
18	4 hrs 15 min		Cured
19	2 hrs 55 min		Cured
20	6 hrs 15 min	17 hrs	Fatal
21	No record		Cured
22	4 hrs 15 min		Cured
23	3 hrs		Cured
24	4 hrs		Cured
25	2 hrs	10 days	Fatal

The average time in the hospital before operation was five hours. The time the patient was in the hospital before operation seemed to have within certain limits but little relation to the outcome. Death occurred in nine of the ten fatal cases within seventeen hours after operation, and this may be safely explained on the basis of post-operative shock, therefore, all of the cases, excepting one, that were able to withstand the operative shock survived. The one case that lived ten days, developed a temperature of 104, a pulse rate of 146 with distention and rigidity of the abdomen, which was probably due to peritonitis. Autopsy was refused.

Blood transfusions helped markedly in the ultimate outcome in this series. Transfusion was employed post-operatively. Saline infusion was used in all cases. Autotransfusion, as recommended by Theis and Henschen²⁸ was never used.

Infection of a persistent character of the abdominal wound developed in five cases, these five cases developed ventral herniæ. One patient had

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a severe hemorrhage from his wound on the ninth post-operative day which we think was due to injury to the pancreas at the time of his accident or at operation, and the pancreatic enzymes digested the suture material and the edges of the wound. This patient developed a massive hernia, indicating that the entire abdominal wall was affected, and which required a secondary suture. In the London Hospital series, four cases of "burst wounds" were reported, and in each case the wound had to be resutured under general anaesthesia, Bailey attributes this to the action of the pancreatic ferments, as indicated by me in a previous paper, as the probable cause of the persistent infections and post-operative hemia that occurred in our cases. A left-sided empyema occurred in one case thirteen days after operation, we think this was due to infection of a traumatic pleurisy produced at the time of the original injury. In support of this idea is the fact that one of our non-operated cases showed at autopsy a contusion of the base of the left lung, and Bailey reported three cases of left-sided pleurisy in his group of thirty-two cases. No persistent hiccup as observed by Bailey in several of his cases was noted by us.

The average stay in the hospital of the cured cases was thirty-two days.

No opportunity has presented itself for me to do a second operation on any of my splenectomized patients.

Griffin²⁹ states "that hyperplasia of lymphatic tissues has been seen occasionally during life, and has been definitely found post-mortem following splenectomy in man." Faltin and Stubenrauch³⁰ found at the time of second laparotomies, one and six years, respectively, that the peritoneum was covered with numerous nodules, showing microscopically the characteristics of splenic tissue, which certainly had not been present at the first operation. Moynihan³¹ reports a personal case, in which a small accessory spleen, after a period of seven years, increased almost to the size of a normal spleen. Lee³² described a case in which a laparotomy was performed for acute intestinal obstruction on a splenectomized patient, and he found the peritoneum covering the small intestine and mesentery covered with small tumors, varying in size from a pin head to one inch by one-half inch, there were 200 to 300 such tumors, and on microscopic examination they were found to be of splenic tissue. It is, therefore, clear to a certain extent at least, that after splenectomy, the functions of the spleen are taken over by remnants of splenic tissue left at operation, accessory spleens and the rest of the reticulo-endothelial system, all of which show hypertrophy. In a case of apparent congenital absence of the spleen Hodenpyl³³ found at autopsy a general compensatory lymphatic hyperplasia.

Pearce,³⁴ Asher,³⁵ and others, have found that the spleen plays an important part in iron metabolism. Asher found that the elimination of iron was considerably increased in splenectomized dogs. Bayer³⁶ observed an increased iron excretion in several splenectomized patients. Pearce has shown that the spleen controls and regulates blood destruction, and, is of the

opinion, that the increased iron elimination is to be explained by increased blood destruction. The bone marrow, according to Mosler,³⁷ becomes red after splenectomy, due to hyperemia, and there are active mitotic figures, and there is an increase in the number of specific marrow cells with a diminution in the amount of fat, these changes, Pearce thinks have to do with the storage of iron.

Following operation in this group of cases, examination of the blood showed a secondary anemia. The decrease in the number of red cells, was accompanied by the usual variations in size, shape and staining qualities that are found in anemia, evidences of red cell regeneration were shown by the presence of normoblasts. Granular basophilic degeneration, or Grawitz's granules, as noted by Morris³⁸ in one case, was observed by us in one instance, the red cells showing this punctate basophilia disappeared from the blood in about two weeks after operation. The normoblasts disappeared from the peripheral blood in from ten to fourteen days but did not reach normal during the stay of the patients in the hospital. The white blood count remained high for three to five weeks and it varied from 14,000 to 30,000 leucocytes. An increase in small lymphocytes was invariably noted, and it amounted to as much as 45 per cent, a small but constant increase in large mononuclears, and transitional cells were observed. White cell regeneration was evidenced by the occurrence of eosinophilic and neutrophilic myelocytes in some cases, these abnormal cells appeared about the end of the first week, reached their zenith between the second and third weeks and disappeared during the fourth and fifth weeks after operation. No eosinophilia was observed during the hospital stay of any of the patients. No studies of the fragility of the red blood cells were made in these cases, which according to Moynihan, is increased. No platelet counts were made by us, but Rosenthal³⁹ studied the effect of removal of the normal spleen on the blood platelet count, in seven cases at Mt Sinai Hospital, and he found that "there was a gradual and constant increase in the number of blood platelets. This increase reaches its zenith during the second week. Blood platelet counts of 1,000,000 to 1,900,000 were observed. The platelet count begins to drop and becomes normal or remains somewhat above normal about the third or fourth week after operation. Observation of these cases for five years after operation has shown their platelet count to be normal or slightly above normal." Moynihan⁴⁰ is of the opinion that the "temporary anemia subsides in about two months' time, and that the increase in lymphocytes persists for about a year, and gives place to an eosinophilia, which increases to about 8 per cent during the third year." Boyd⁴¹ states definitely that "the anemia disappears at the end of two months." Pfeiffer and Smyth,⁴² state that "individuals splenectomized for traumatic rupture usually show a definite and persistent anemia, which requires prolonged observation and treatment." Examinations have been made of the blood in a number of our cases for a period of three years or more and in one

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for a period of seventeen years, and every case showed a slight secondary anemia and a slight leucocytosis. The blood picture found in the one case seventeen years after splenectomy is as follows:

Red blood count	4,800,000
Hæmoglobin	75 per cent
White blood count	13,000
Polymorphonuclears	70 per cent
Lymphocytes	30 per cent

As to the late effects of splenectomy on the physical welfare of these individuals. No untoward effects were discovered. We have observed one case for seventeen years and he has always been in excellent condition from his history and physical examination, excepting for a very mild anemia. Regular periodic health examinations were carried out for short periods of time in these cases but it was impossible to make observations for more than three years and they were all in excellent physical condition at the time of their last examination. There was no evidence of decreased resistance to infection in these cases. This is contrary to the conclusions drawn by Morris and Bullock,⁴³ as they state "that there is often noted clinically decreased bodily vigor and resistance." Attention has been called to the inherent fallacy of all conclusions drawn from experimental work by Michelson⁴⁴ and Rost⁴⁵, and they point out the fact that after splenectomy, as after the operative removal of any abdominal organ, the body is necessarily in a weakened condition, and therefore any infection may develop, and is more virulent. Observations on splenectomized animals, in all work reported to date, have not been carried out for a sufficiently long period of time after operation. Rost also states that "there is no evidence of any decreased resistance of splenectomized persons to infection." Moynihan's opinion is the same, and Bailey could find no decreased resistance to infection, in the follow-up of his patients after splenectomy. Late deleterious effects of splenectomy on health are apparently absent, and if present, they are, for practical purposes, negligible.

Open wounds. These penetrating wounds consisted of five gunshot wounds and one stab wound. They are rare in military surgery and still rarer in civil practice. Laspeyres⁴⁶ reported seven splenectomies with three recoveries. Abadie⁴⁷ reviewed twelve cases of war injuries of the spleen operated upon by Depage,⁴⁸ and of these twelve splenectomies four recovered. Willems,⁴⁹ as quoted by Abadie, states, "that splenectomy is constantly fatal in military surgery" and his conclusion was based on the fact that he lost five consecutive cases in which splenectomy was performed. General Ireland in a personal communication to Pool, reports that the incomplete records for our troops in France show that ten splenectomies were performed and eight of the ten were fatal. Open wounds of the spleen are fatal unless an immediate operation is performed. Splenectomy is the operation of choice and we feel that Abadie is correct in pointing out that

splenectomy is serious in proportion to the already existing hemorrhage and to the injuries of the other organs which have already threatened the patient's life Stetten⁵⁰ reported a stab wound of the spleen, which was treated by suture, and the patient recovered

Owing to the scarcity of published reports of open wounds of the spleen, it seemed that a report of the following six cases might prove of interest

CASE HISTORIES

CASE I—*Stab wound of the spleen* Male, age twenty-four years, was admitted to the hospital, July 23, 1906, at 12 30 A M with a stab wound in the left flank The wound was three-fourths of an inch in length, and was located between the tenth and eleventh ribs, about five inches from the spinous process of the twelfth dorsal vertebra, and it passed upward into the abdominal cavity The wound was bleeding profusely Liver dulness was obliterated Temperature on admission was 100, pulse 120, and patient was in shock At operation the spleen was found to be pierced through about an inch from its lower border and was bleeding profusely from the inner aperture The spleen was removed There was a hemorrhage under the serous coat of the colon, and a wound in the mesentery Three days after operation the patient developed a temperature with distention of the abdomen, the wound was opened and drained but no pus was found He became very septic and died the following day

CASE II—*Gunshot wound of spleen* Male, age twenty-six years, was admitted to the hospital, January 21, 1905, at 9 00 A M Patient was found on the sidewalk in shock Temperature 99.4, pulse 150 On examination he was pale and dyspnoeic and showed a bullet wound in the left shoulder, two bullet wounds in the left thigh and one in the back about three inches to the left of the midline and under the rib The abdomen was rounded, tense, and was dull on percussion in the flanks, but tympanitic over the centre, and was diffusely tender Operation was performed one hour after admission, and on opening the abdomen through a left rectus incision a considerable quantity of dark blood escaped The spleen was markedly enlarged from intracapsular hemorrhage and showed a deep furrow on its external phrenic surface, which was bleeding profusely The spleen was removed The condition of the patient was extremely poor while on the table and during this time an intravenous injection of normal saline was given After his return to bed he vomited several times moderate quantities of bile-colored and coffee-colored material and was treated by gastric lavage The pulse rose steadily, however, and he died thirty-six hours after operation

CASE III—*Gunshot wound of the spleen* Male, age thirty years, was admitted to the hospital, July 5, 1906, at 1 00 P M He was shot in the left axillary space and was suffering great pain and also complained of nausea On examination the patient was conscious, pale, in a cold sweat, the mucous membranes were almost white The abdomen was rigid, tender and dull on percussion in both flanks In the anterior axillary line between the tenth and eleventh ribs there was a bullet wound of entrance from which blood was oozing At operation, one-half hour later, through a left rectus incision, the spleen was found to be perforated and it was removed A perforation was found in the diaphragm and the sucking of air indicated injury to the left lung A Mikulicz tampon was placed beneath the diaphragmatic opening The patient made an uneventful recovery and nothing unusual was noted except that the urine was bloody for several days after operation

CASE IV—*Gunshot wound of the spleen* Male, age twenty years, was admitted to the hospital, December 27, 1907, at 10 30 A M Temperature 99, pulse 134, respiration 50 Patient was said to have been shot in the back and when first seen he was in extreme shock, pale and pulseless He was treated for shock and showed some reaction

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He complained of abdominal pain. The abdomen was rigid and tender throughout. Operation was performed two hours later. A midline incision was used and the abdominal cavity was filled with blood. Perforation of the spleen and liver. The spleen was removed and an iodoform drain was inserted down to the wound in the liver which was not apparently bleeding at the time. The bullet was found free in the abdomen. The patient died four hours after operation.

CASE V—*Gunshot wound of the spleen*. Male, age twenty-one years, was admitted to the hospital, August 5, 1911, at 9 45 P M. He was shot in the abdomen and complained of abdominal pain. The wound of entrance was in the epigastrium, and the bullet was felt beneath the skin, on the left side of the back. On examination, patient was conscious and pale. Temperature 100, pulse 92. The abdomen was slightly rigid in the left upper quadrant and was slightly tender over splenic area. At operation, four hours later, the abdomen was opened through a left rectus incision and a large amount of free blood was found, the spleen was found to be lacerated and it was removed. A circular opening in the greater curvature of the stomach was found near the pylorus and this was closed by suture. Bleeding points in the gastro-omentum were ligated. Recovery was uneventful.

CASE VI—*Gunshot wound of the spleen*. Male, age forty-one years, was admitted to the hospital, April 23, 1922, at 8 00 A M. Temperature 98.6, pulse 92. Patient was found in a coal cellar with three bullet wounds over the precordium. He stated that he had shot himself. The three bullet wounds of entrance were on the left side at the level of the fifth interspace in the mid-clavicular line. One wound of exit was just below the twelfth rib, about three inches to the left of the spine. There were powder marks around the three wounds of the chest, which were separated from one another by a distance of one-half inch. The patient was pale and in great pain. Rigidity of the abdomen was found in the left hypochondrium. Operation was performed one hour later and through a left rectus incision the abdomen was opened and found to be filled with blood. The spleen was torn and there was active bleeding from the splenic vessels. A large perforation was present in the diaphragm on the left side which sucked in air with each inspiration. The condition of the patient became so poor during the operation that the vessels at the root of the spleen were tied with tape and the free ends brought out through the abdominal wound. The perforation in the diaphragm was closed with a Mikulicz drain and the area about the spleen was packed with iodoform gauze. The patient did not rally from the operation and died twenty-four hours later.

In the five gunshot wounds the spleen alone was injured in only one case, two cases had perforations of the diaphragm, one a perforation of the stomach and in the fifth there was a wound of the liver. In the stab wound case there were associated injuries to the colon and mesentery. In this series we had a mortality rate of 66 and 2/3 per cent which is in keeping with the published statistics of other observers.

SUMMARY

To summarize we may say

- 1 Traumatic rupture of the spleen occurs most frequently in childhood and adolescence
- 2 The absence of external marks on the body of a patient presenting abdominal symptoms following trauma is an important diagnostic clue
- 3 Immediate operation should be performed, regardless of the condition of the patient and splenectomy is the operation of choice

- 4 The presence of associated lesions increases operative mortality
- 5 Blood transfusion post-operatively is of great value
- 6 A slight anemia that lasts for years associated with a slight leucocytosis follows splenectomy
- 7 The health of persons splenectomized for trauma is not adversely affected

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SPLENECTOMY

REPORT OF A CASE WITH PATHOLOGY UNCLASSIFIED *

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AND

R P BALL, M D (BY INVITATION)

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THE following case report is offered to show that even in cases of splenomegaly which are atypic, splenectomy may prolong or save the life of the patient

The patient, a man thirty years of age, came to the Clinic July 29, 1927, complaining of pain in the left side, a fissure in ano, loss of weight, sleeplessness. He had had the fissure since February. The pain in the left side started two weeks before this visit, beginning as a sharp pain. It was especially evident when the patient stooped over and when he took a deep breath. The patient had had no cough but had had a slight fever. He had lost about fifteen pounds in weight.

There was nothing of significance in the family or personal history. As to his present illness there were no symptoms referable to the digestive, cardiovascular or respiratory systems except shortness of breath which was due to the pain. He tired easily and stated that he slept poorly.

Physical examination revealed a tall, slim man weighing 142 pounds (normal weight 154 pounds). His temperature was 100°F, his pulse rate 92. On respiration there was diminished movement of the left side with suppression of breath sounds over the left base. There were no rales. In the abdomen there was a visible mass in the left side extending over the splenic area to the midline and below the umbilicus. This mass was slightly tender on palpation, and there were definite coarse crepitations over the spleen. There was a small indurated area on the left buttock about one and a half inches from the anus which was discharging feces.

Aside from the fistula the clinical impressions were splenomyelogenous leukemia, Banti's disease or tuberculosis of the spleen.

An X-ray examination of the chest gave the following information. A short cervical rib on the left side, the left diaphragm level with the right or slightly elevated, fibrotic infiltration in the lungs extending well out into the infraclavicular region.

August 9, the spleen appeared to be very large, it filled Traube's space and extended medially to the midline. A notch was felt at the umbilicus but the lower pole extended almost to Poupart's ligament. The surface was slightly irregular but the consistency was not very hard nor was the edge very sharply defined. It did not feel like a leukemic or Banti's spleen, and was scarcely firm enough to be an amyloid spleen. It felt more like an enlargement due to a chronic infection such as tuberculosis or lues. X-ray therapy and potassium iodid were advised, to be followed by splenectomy if these measures were not effective.

Six weeks after receiving X-ray treatment the patient had gained thirteen pounds and felt much better. At this time the spleen extended only to the level of the umbilicus.

A von Pirquet test, October 7, was positive.

November 3, the spleen felt smooth, was very firm, and extended the breadth of three fingers below the umbilicus. On account of the accompanying fistula in ano and the positive von Pirquet, it was believed that this was a tuberculous or possibly an amyloid spleen and splenectomy was advised.

* Read by title

SPLENECTOMY

The successive blood counts to this time are shown in Table I

At operation, November 11, a spleen weighing 2900 gm and measuring $30 \times 7 \times 18$ cm was removed (Fig 1) The liver was found to extend for almost a hand's breadth below the costal margin It seemed to be normal in color and there was no evidence of cirrhosis

A transfusion of 500 cc of blood was given immediately after the operation

Pathological Report—Gross description A spleen weighing 2900 gm and measuring $30 \times 7 \times 18$ cm It is deeply notched, smooth and flabby, and the capsule is tense The anterior surface is dull white and lustrous Serial sections show a dark red, velvety cut surface with absence of markings of the splenic nodules, considerable

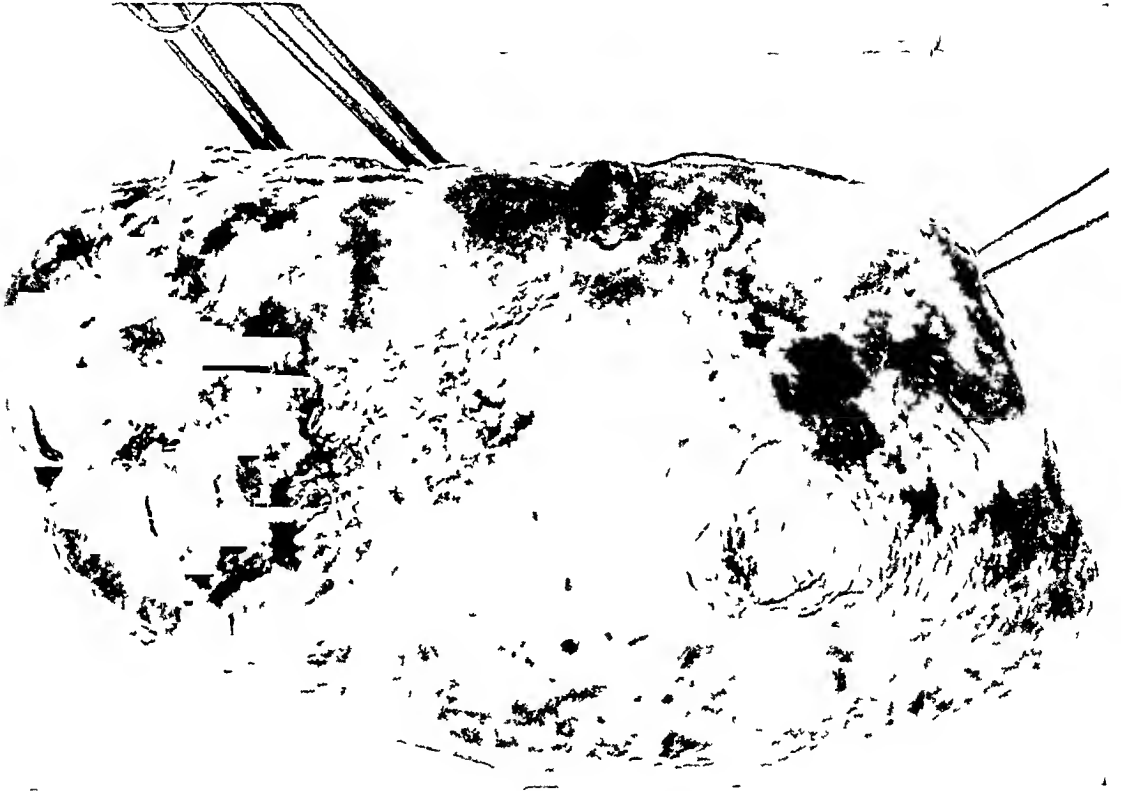


FIG 1—Gross specimen of spleen weighing 2900 gm and measuring $30 \times 7 \times 18$ cm

pulp is obtained on scraping A single, discrete, pale yellow, firm nodule 15 mm in diameter lies immediately beneath the capsule on the anterior surface The cut surface of this nodule is homogeneous and smooth The zone surrounding the nodule is dark red and hemorrhagic in appearance

Microscopical Description—The sections show a loss of the Malpighian corpuscle markings The endothelial leukocytes are greatly increased in number with proliferation of the lining cells and filling of the sinuses A large number of lymphocytes are present in the sinusoids In some places these appear to have a separate delicate reticulum suggesting lymphoblastoma The endothelial leukocytes show a few mitotic figures, and those lying in the sinuses contain hæmosiderin A few of the smaller vessels show a thrombosis The picture is suggestive of an aplastic lymphoblastoma (Figs 2 and 3)

Tentative Pathological Diagnosis—Lymphoblastoma—aplastic type

Post-operative Course—The wound healed rapidly and the patient had a smooth convalescence

The successive blood counts during his stay in the hospital are given in Table I February 17, 1928, the fistula in ano was excised



FIG 2—Photomicrograph (x140) of section of spleen removed in case of splenomegaly. Note marked proliferation of endothelioblasts and loss of Malpighian corpuscle markings

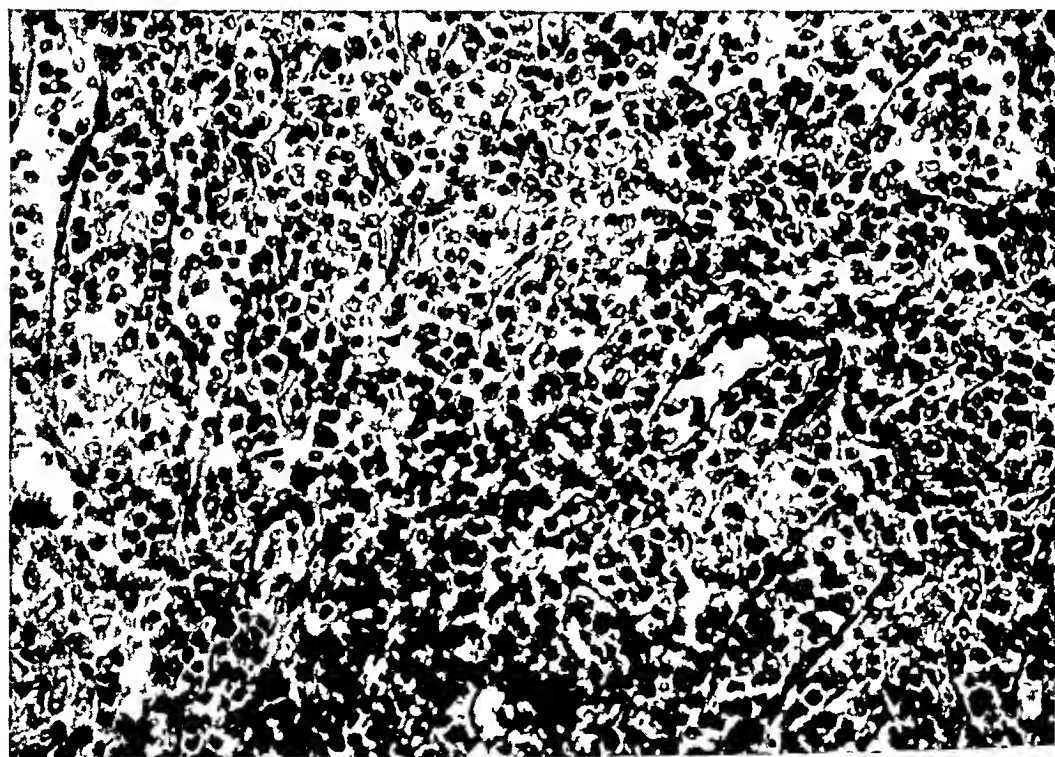


FIG 3—Photomicrograph (x250) of section of spleen removed in case of splenomegaly. Note the greatly increased number of endothelioblasts and the filling of some of the sinusoids with lymphocytes and endothelioblasts

SPLENECTOMY

When last seen, March 15, 1928, the patient was feeling well and was sleeping well. His blood count on this date is given in Table I.

On account of the uncertainty as to the pathological diagnosis, sections were sent to various pathologists from whom the following reports have been received:

(1) Chronic myeloidization of the spleen, with anemia. What this condition really means, I am far from certain.

(2) Endothelio-blastic proliferation, microscopic not pathognomonic of any lesion.

(3) Thrombophlebitic splenomegaly.

(4) Stasis with endothelio-blastic proliferation, thrombosis and minute infarcts. Usually associated with a thrombosis of a splenic vein.

(5) Aplastic type of splenomyelogenous leukemia.

TABLE I

Successive Blood Findings in Case of Splenomegaly with Unclassified Pathology

Date	R B C	W B C	Ng	Differential Count			Trans
				Neut	S in lymph	Lg lymph	
7-29-27	4430000	2700	80	45	51	1	
7-30-27		2000					
8-1-27	4480000	1900	85				
9-29-27	4200000	2000	85	32	58	10	
11-4-27	4300000	1800	90	39	38	17	
Operation—Splenectomy							
11-8-27	3710000	3300	75				
11-10-27	2910000	2100	75	44	16	28	12
11-14-27	3620000	7000	70	70	15	15	
11-16-27	2880000	7300	55-60				
11-18-27	2900000	7800	60				
11-21-27	3600000	6300	60				
11-25-27	2450000	4100	55-60				
11-26-27	3200000		60				
11-28-27	2560000	3800	55-60				
12-12-27	3260000	6050		21	70 (6% mononuclear)		3
1-4-28	3120000	3800	65	13 (Marked increase in central 2% myelocytes B)	78	1	3 pallor
2-16-28	3520000	4800	80	5	75	20	
3-6-28	5140000	7850		3	72	14	11

Discussion—There is no system in the body regarding the pathology of which so little is known as the reticulo-endothelial system, and there is no system the diseases of which are fraught with graver menace. The spleen, in particular, occupies a unique position even within this system, for it is apparently of little, if any, value after birth, as far as is known the diseases which affect it have their origin in other organs, and once it has become involved in a disease process, the progress toward a fatal termination is usually unaffected by any form of treatment except in certain instances by the removal of the organ itself.

Splenomegaly may be due to microorganisms, especially to those which reach the spleen in the course of acute or subacute infections such as tonsillitis, sinusitis, osteomyelitis. Tuberculosis is a well-known cause of splenomegaly, as is malaria, but in splenomegaly due to any of these causes

either the organism can be isolated or the microscopic appearance is pathognomonic. No such organisms could be isolated in this case nor, as is shown by the varying reports by pathologists, was there a pathognomonic appearance of the spleen. In every case of splenomegaly of known etiology, characteristic changes are present, but no such changes were demonstrable in this case. The function of the spleen in the production of anemia and of leukemia is not known except that the enlarged spleen has a destructive effect upon the red blood cells and a productive effect upon the white blood cells. In this case anemia was not present excepting for a brief period after operation nor was leukemia manifested at any time. In fact, as far as we have been able to discover, no case of splenomegaly has been reported in the literature in which the aleukemia has been as marked as in this case. Nevertheless it may be noted that the microscopical appearance of the spleen suggested to one of the pathologists that we were dealing with splenomyelogenous leukemia.

The roentgenographic appearance of the lungs together with the positive von Pirquet test would suggest that this was a case of tuberculous splenomegaly, but this again is apparently ruled out by the microscopic findings.

Uncertain though the pathology in this case may be, nevertheless the fact remains that in every case of splenomegaly there must be some definite etiological factor. In this case the true cause may be disclosed at a later date, perhaps only at autopsy. The blood picture, that is the increasing percentage of lymphocytes, suggests, however, that the patient may come back presenting a true clinical picture of lymphatic leukemia. Whatever the final outcome may be, it seems worth while to report this case in the hope that together with the reports of other cases, the pathology of which is similarly uncertain, it may at some time aid in throwing some light upon the function of this still mysterious portion of the mysterious reticulo-endothelial system.

A REVIEW OF 500 SPLENECTOMIES WITH SPECIAL REFERENCE TO MORTALITY AND END RESULTS *

BY WILLIAM J MAYO, M D
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It is my purpose in this paper to evaluate briefly our experience in the clinic in those dyscrasias which have led to the removal of the spleen, and to comment in general on what may be expected from splenectomy as borne out by the statistics

I have grouped the cases under four headings, having in mind the clinical rather than the pathologic aspects, necessarily such grouping is only approximate (1) diseases associated with abnormality of the white blood cells and related structures, (2) diseases associated with changes in the red blood cells, and blood platelets, (3) diseases due to infectious and toxic agents, and (4) miscellaneous diseases Giffin and his associates have made a study of the blood changes in these cases and have correlated them with the clinical picture, and MacCarty and his associates have studied the pathology of the removed spleens and in due time will present their findings

FUNCTIONS OF THE SPLEEN

The spleen is a part of the reticulo-endothelial system, as described by Landau and Aschoff, which includes the lymphoid tissues and certain endothelial and connective tissues It is a hemolymph gland and is probably most closely associated in function with Kupffer cells of the liver The arteries of the spleen as they separate into smaller vessels lose their middle and outer coats in the parenchyma of the spleen, so that the endothelium of the capillaries is continuous with the endothelium of the sinuses The blood of the capillaries therefore passes directly into the sinuses themselves The splenic vein joins with the portal vein and carries about 20 per cent of the volume of the portal circulation

The functionally active cell of the spleen, which corresponds to the Kupffer cell of the liver, is a large mononuclear endothelial leukocyte which has an exceedingly efficient phagocytic action and plays an important part in removing bacteria from the blood, as in typhoid and tuberculosis, and protozoa, as in syphilis and malaria The strainer function of the spleen is well exemplified in those splenomegalias in which the spleen is unable to deliver bacteria, protozoa, and toxic material with sufficient speed to the liver for destruction and detoxication The retention of this deleterious material in the spleen may lead not only to splenic enlargement but to systemic reinfections, as is known to be the case in syphilis and certain forms of sepsis

It is worthy of note that the large supply of well oxygenated arterial

blood carried by the splenic artery is converted into venous blood without exerting an adequate known function. This oxygen is evidently not lost in combustion for the purposes of heat and energy. The fact that oxygen is utilized in the spleen in large quantities necessarily means that some other substance is oxidized. There is little evidence and no logical reason for believing that de-oxygenation of the blood in itself is a function of the spleen, for a sufficient quantity of de-oxygenated blood is already supplied to the liver through the portal vein. The question of whether or not the oxidation is for the purpose of destruction of undesirable substances (detoxication theory) or for the purpose of elaborating some complex substance, (for example, the highly complex hæmoglobin protein molecule), offers an interesting field for investigation. It might also be suggested that these oxidized substances are prepared in the spleen for the purpose of further treatment by the liver.

The removal of the normal spleen in cases of traumatism in man, and its removal in experimental animals, does not seem to cause permanent abnormal disturbance. On removing the spleen one is struck by the enormous amount of venous blood which it contains. It has been shown by Barcroft and Stevens that in the dog about 20 per cent of the total blood volume may be stored temporarily in the spleen. The spleen contains a considerable amount of nonstriated muscle tissue and is known to possess a certain rhythmic contraction comparable to that of the gastro-intestinal tract and the uterus. It may be assumed that in times of stress stored blood is impelled through the portal circulation into the general circulation by splenic contractions, which possibly account for the pain in the left side so often experienced by long-distance runners. It may also account for the tradition that the ancients removed the spleen of runners in preparation for the Marathon races.

The spleen has some connection with the sympathetic nervous system through scanty fibres to the capsule, but it would appear to act largely through the influence of certain hormones which as yet have not been identified.

Normally the spleen probably does not produce white blood cells in the adult, this function or dysfunction of the spleen is apparent in splenomyelogenous leukemia.

Approximately 20 per cent of the volume of the arterial blood is oxygen. When the red blood cells are reduced in number, suboxidation results. The relief which is sometimes manifest in the anemias on increasing the respiratory oxygen intake artificially may be due in part to correction of the suboxidation.

The embryonic red blood cells have dimly visible nuclei which disappear when the oxygen-bearing function becomes established. Since the adult red cells do not have nuclei they do not reproduce themselves, and must be replaced. The work of Ashby of The Mayo Foundation showed that red blood cells continue their oxygen-bearing function for at least six or seven weeks and probably longer. It should be noted that there are one or more atoms of iron to each molecule of hæmoglobin, showing the foundation for

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the improvement which sometimes follows the use of iron in the anemias

The red blood cells and the blood platelets are formed in the bone marrow. The function of the spleen in destroying worn out red blood cells and blood platelets is an important one.

The experiments of Mann and his co-workers show that bile is not formed in large amounts in the liver, but that one of the functions of the liver is to filter bile from the blood. The destruction of the red blood-cells, which produce the pigments of the bile, is accomplished largely in the bone marrow (where also these cells and the blood platelets are formed), in the spleen, in the Kupffer cells, and, to a less extent, in the reticulo-endothelial tissues of the body generally.

In the removal by the spleen of worn out red blood cells and blood platelets from the blood-stream lies the explanation of increased function of the spleen in those specific splenic enlargements which accompany hæmolytic jaundice and hæmorrhagic purpura, and one may surmise that although the splenomegaly in hæmolytic jaundice and hæmorrhagic purpura may to some extent be a work hypertrophy, any enlargement of the spleen means distinct danger to the red blood cells, without regard to the nature of the enlargement, and probably will be accompanied by anemia.

In splenic anemia the red blood cells, and often the white blood cells, are reduced in number, the white cells not infrequently to 3,500 or below. In the late stages of this particular dyscrasia, the so-called Banti's syndrome of cirrhosis of the liver may occur, suggesting that diffuse irritating products are filtered from the blood-stream by the spleen or are formed in it. Failure of the liver to detoxicate these products leads to generalized hepatic fibrosis as the result of the attempt to encapsulate them. Just what these irritating substances may be is not known, but from our knowledge of the pepper and alcoholic cirrhoses originating in the gastro-intestinal tract we can surmise that they are chemical in nature. Giffin and Brown have shown recently that the blood volume is increased in cases of simple splenomegaly previous to the development of anemia, this indicates that there is an early factor in the disease which causes splenic enlargement with an increased circulatory bed.

I realize that this brief survey of the experimental and clinical fields is unsatisfactory and lacks greatly in detail, but at least it gives a perspective.

OPERATIVE EXPERIENCE

Between April 1, 1904 and March 1, 1928, splenectomy was performed in the clinic in 500 cases, with a mortality of 10 per cent. In speaking of the death rate, I refer to the deaths in the hospital. Many of the patients recovered from the operation, but for various reasons were not dismissed from the hospital and died there from causes other than the splenectomy. Eighty per cent of the patients who recovered from the operation and are now living are in good condition, and the ultimate results are even more satisfactory than a cursory examination of the statistics might lead one to believe. As Bloodgood has pointed out in connection with a follow-up of patients operated

on for cancer. "Whereas bad news travels quickly, those patients who are difficult to trace, when heard from usually prove to be well." Further, we assume that all deaths in a series of cases occur from the disease, but it is only just to consider the natural death rate in a period of twenty-four years.

GROUP 1—Diseases Associated with Abnormality of the White Blood Cells and Related Structures—Splenectomy was performed in fifty-four cases because of abnormal changes in the white blood cells and related structures, associated with enlargement of the spleen.

	Hospital	
	Patients	mortality
Spleno-myelogenous leukemia	45	3
Lymphocytic splenomegaly	8	
Hodgkin's disease	1	

Spleno-myelogenous Leukemia—In forty-five cases of splenectomy for spleno-myelogenous leukemia there were three deaths in the hospital. Spleno-myelogenous leukemia has been looked on as an incurable disease, and superficially it would appear that there was little excuse for removing the spleen. However, if we consider first that what we call spleno-myelogenous leukemia may be a terminal stage of various types of blood dyscrasias which are recognized only when they have reached a fatal stage, perhaps to a certain extent we are naming a prognosis rather than the actual disease. Splenectomy is suggested in these cases by the fact that any treatment which reduces the size of the spleen improves the condition of the blood and thereby the condition of the patient.

Patients in this group have lived and have been able to work for a number of years after splenectomy. At no time has the blood become normal, but great, and, in some instances, prolonged palliation has resulted. The results are better than they appear, because in cases of possible spleno-myelogenous leukemia, when the condition of the blood approaches normal after splenectomy, it is assumed that the disease was not true spleno-myelogenous leukemia, and the case is classified with the splenic anemias or is left unclassified. These cases will be explained later in the light of future knowledge.

It has been found that by reducing the size of the leukemic spleen either with X-ray or radium preliminary to operation, the spleen can be removed with not to exceed 5 per cent mortality. In younger and middle-aged patients in the early stages of this apparently hopeless condition, the merits of splenectomy should be considered.

Lymphocytic Splenomegaly—Splenectomy was performed in eight cases of lymphocytic splenomegaly with no deaths. These cases are closely related to the cases of generalized lymphosarcoma, and possibly also to lymphatic leukemia on the one hand and to Hodgkin's disease on the other. They vary greatly in the degree of malignancy. Half of them apparently have been of a benign type and the patients are living from one to six years after operation.

Hodgkin's Disease—The spleen was removed in one case for a curious

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condition which was classified temporarily as localized Hodgkin's disease. The classification of this case awaits further knowledge.

GROUP 2—*Diseases Associated with Abnormality of the Red Blood Cells (and Blood Platelets)*—Splenectomy was performed in 330 cases for enlarged spleen associated with abnormality of the red blood cells.

	Hospital	
	Patients	mortality
Splenic anemia	140	15
Hæmolytic jaundice	88	4
Hemorrhagic purpura	27	1
Perniciou anemia	62	4
Polycythemia vera	3	1
Indeterminate hemorrhagic disease	4	
Acute aplastic anemia	2	
Chronic aplastic anemia	2	
Chronic hæmolytic anemia	1	
Indeterminate congenital jaundice	1	

Splenic Anemia—Splenectomy for splenic anemia was performed in 140 cases. There were fifteen deaths in the hospital. More than half the patients are living, and all but six are in satisfactory condition. The hospital death rate in this group is high, but when it is considered that a goodly proportion of patients operated on were in the terminal stages with advanced cirrhosis of the liver, ascites, and œdema, and that many of these recovered and remained well for a term of years, the results are satisfactory, and demonstrate the remarkable power of the liver to regenerate. This encouraging showing, however, led to operation in many cases in which conditions were such that the risks, although justified, were great. Ten per cent of the patients who died during the ten year period after splenectomy for splenic anemia died from gastric hemorrhage. It is assumed that bleeding was due to varices in the lower part of the œsophagus and around the cardia of the stomach.

Hæmolytic Jaundice—Splenectomy was performed in eighty-eight cases of hæmolytic jaundice, with four deaths in the hospital. Eighty-one of the patients have been traced. Seventy-three are known to be living, of whom seventy-two are in good condition. Splenectomy in hæmolytic jaundice stands out as a life-saving operation. It was first used in the clinic in 1911, and our interest in the procedure was given further impetus by the publication in 1915 by Elliott and Kanavel of their splendid contribution on the value of the operation in hæmolytic jaundice.

Hemorrhagic Purpura—Splenectomy was performed in twenty-seven cases of hemorrhagic purpura, with one death in the hospital. Twenty-six patients are living and in good condition. Here again is a triumph for splenectomy. It is most important to make a correct diagnosis before coming to a decision concerning surgical treatment. Acute aplastic anemia especially simulates hemorrhagic purpura, and differentiation of the two may at times be very difficult.

Pernicious Anemia—The modern treatment of pernicious anemia by a diet containing liver and high in vitamins has at least temporarily replaced splenectomy. Splenectomy was performed in sixty-two cases of pernicious anemia, with four deaths in the hospital. Three of these deaths occurred in the first nineteen cases, in which the operation seemed justified only in the late stages of the disease. Splenectomy should be performed, if at all, only when the patient is on the upgrade following transfusions and other methods of rehabilitation. The temporary improvement which followed removal of the spleen was marked in practically every case, and the prolongation of life in 25 per cent of the cases was about two and a half times the life expectancy if splenectomy had not been performed. None of the patients was considered cured, for if apparent cure resulted, the case was placed in a different classification since probably it was not true pernicious anemia. I think every case should be carefully considered on its merits in order to detect the occasional doubtful case in which splenectomy may be advisable. There is a group of cases in which there is achlorhydria and what seems at the time to be secondary anemia in which the other features of pernicious anemia have not developed, in these splenectomy might logically be considered if the spleen is enlarged.

Polycythemia Vera—Splenectomy was performed in three cases of polycythemia vera, with one death. The results in the two cases were extraordinarily good. While the patients are not well, they have been able to work for several years.

GROUP 3—*Diseases Due to Infectious and Toxic Agents*—In the group of splenomegalies in which the spleen acts as a filter and removes microorganisms and toxic agents, splenectomy has a field of usefulness. The enlarged spleen was removed in eighty-six cases in this group.

	Hospital Patients mortality	
Tuberculosis of spleen	9	1
Syphilitic splenomegaly	10	1
Acute, subacute and chronic septic splenomegaly	30	7
Portal cirrhosis	37	7

Tuberculosis of the Spleen—In nine cases in which the tuberculosis appeared to be confined to the spleen, seven patients have remained well over a long period of years since splenectomy. One patient died of generalized miliary tuberculosis which came on immediately after operation, possibly due to direct venous contamination in the course of the operation.

Syphilitic Splenomegaly—There were ten cases of splenectomy for syphilitic splenomegaly, with one death in the hospital. These patients all had advanced anemia, large spleens, secondary gummata in the liver, and were unable to maintain a negative phase under antisyphilitic treatment carried on for months. The removal of the spleens, which in some instances were found to contain spirochetes and small gummata, was followed by rapid recovery.

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The improvement in these resistant cases following splenectomy and subsequent treatment amounted to cure

Septic Splenomegalies—The septic splenomegalies are unsatisfactory cases for operation. In the thirty acute, subacute, and chronic cases in which splenectomy was performed, there were seven deaths. In the more acute cases in which bacteria were cultivated from the blood, the results were poor, and it probably would have been wise to delay the operation until a greater degree of natural immunity had been established. In the cases in which septic endocarditis was present at the time of the splenectomy, there were no cures. In the chronic cases the results were much better, where natural immunity had been established the results were good, and the risk small.

Portal Cirrhosis—The results of splenectomy in the Banti stage of splenic anemia for the relief of cirrhosis of the liver were so extraordinarily good as to lead to the removal of the spleen in thirty-seven cases of cirrhosis of the liver in which the spleen was only moderately enlarged. The operation was performed late in the history of the disease which was evidently of gastrointestinal origin. There were seven deaths in the hospital in this series. Although there were brilliant exceptions, the results in these cases on the whole were only fair, not better than in a comparable group of cases in which some type of Talma-Morison operation had been performed with less risk.

GROUP 4—*Miscellaneous Conditions*—Splenectomy was performed in thirty-one cases for miscellaneous conditions

	Hospital	
	Patients	mortality
Gaucher's disease	7	2
Ruptured spleen	4	1
Wandering spleen	2	
Hemorrhagic cyst	2	
Multiple serositis (Pick's disease)	1	1
Eosinophilia with splenomegaly	1	
Neutrophilia with splenomegaly	1	1
Hemangioma	1	
Condition necessitating secondary splenectomy	9	
Unclassified	3	1

Gaucher's Disease—Splenectomy was performed seven times for Gaucher's disease. The five patients who lived were greatly improved and, although they were not cured, were able to work and earn a living.

Time does not permit me to discuss further this interesting group of cases, which I have tabulated merely for general information.

ABSCESS OF THE SPLEEN

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ABSCESS of the spleen is an unusual and very interesting condition clinically, but not so rare as one is led to believe by the number of reported cases in the literature. The more notable earlier papers on the subject are those of Grand-Moursel, who collected fifty-seven cases in 1885, Esau's report of seventeen cases of typhoid abscess in 1903, and Kuttner's collection of one hundred and sixteen cases in 1907. Elting, in a very able paper read before this association in 1915, covered the subject admirably and added the report of his own case. Since then other important contributions on various phases of splenic suppuration are those of W. J. Mayo, Balfour, Cutler, Inlow, A. F. Wallace, Lenormant et Seneque, Morel, Dambrie et Tapie, Merklen, Froelich and Stulz, Sabrazes, Pauzat and Laubie, Montel, Kreke, and Krumbhaar.

We are presenting the report of three cases of abscess of the spleen operated upon with recovery, the first that of Dr. John H. Jopson and the second that of a colleague, Dr. Edward J. Klopp, to both of whom I am indebted for the privilege of including their case reports in this paper. The third case is a personal observation.

CASE I.—Doctor Jopson's case report. Female, white, age twenty-six years, Jewish, six children. Puerperal sepsis in August, 1926, following birth of her last child. Treated in another hospital for this condition. Bears scars of several incisions on extremities, where abscesses were opened. Evidently had a septicæmia at this time. Admitted to the Presbyterian Hospital, November, 1926. Chief complaint, pain in left upper abdomen. Patient was emaciated, running a moderate temperature, 99–100, secondary anemia, white blood count 16,000. Smooth, rounded swelling in the left hypochondrium, diagnosed as enlarged spleen. X-ray and physical examination, a moderate amount of fluid in the left pleura. No marked elevation of diaphragm on either side. Pelvic examination, thickening of broad ligaments. This most marked on left. Urine examination, moderate number of white cells. Blood culture sterile. Operation through left rectus incision. Pus evacuated immediately beneath costal margin. It contained thick, yellow pus, which was sterile on culture. The walls were ragged and sloughing. Diagnosis, abscess of the spleen, with perforation of the capsule. Abscess cavity drained. Gradual improvement. Prolonged convalescence, with one or two periods of prolonged elevation of temperature, without a definite cause. Left pleural cavity cleared. Discharged from hospital five months later with a sinus still draining. Admitted five months later with an unclosed sinus, and X-ray examination showed a small collection in the left subphrenic region. Reoperation. Excision of sinus opening, extension of incision upward to costal margin, counter incision in the tenth interspace, mid-axillary line, and drainage of subphrenic abscess. Complete healing followed this procedure.

Doctor Jopson regards this case as splenic abscess, probably in the lower pole, following puerperal sepsis with perforation of capsule and secondary collection in subphrenic area and left hypochondrium. The interesting features are (a) the etiology, (b) the sterility of the abscess when drained, (c) the association of subphrenic abscess. All these features of course have been well recognized as present in a certain percentage of cases, greater or lesser, of splenic abscess.

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CASE II—A woman fifty-seven years of age entered Jefferson Hospital, September 19, 1923, complaining of abdominal pain and difficulty on urination. She had scarlet fever, measles, and chicken-pox during early childhood, menstruated first at the age of nine and passed the menopause at forty-nine. Her menstrual life was somewhat irregular and during the latter part of it the flow was more profuse than normal. She gave birth to one child at the age of thirty-two. There is no history of miscarriages or pelvic infection. For many years she has suffered from flatulent indigestion and has always been constipated. She thinks her present trouble began three years ago with headache, loss of appetite and soreness in the abdomen. One year ago she had an acute abdominal attack of indefinite character lasting three days. She complains of feeling a tumor in the lower abdomen which interferes with urination. During the last six months her condition has grown worse, characterized by fever, increasing weakness and soreness in the abdomen. Physical examination reveals a very large and excessively fat pallid individual. Her teeth are in very bad condition. The lungs are clear, but there is a loud systolic murmur heard best over the apex of the heart. There is oedema of both feet and ankles. The abdomen is distended and there is felt a tender rounded mass in the left upper quadrant extending under the left costal margin, and another mass in the lower abdomen, which, on bimanual



FIG. 1—A tumor which corresponds in position and shape to an enlarged spleen and which is tympanic on percussion is pathognomonic of this variety of splenic abscess (Wallace)

examination feels like a uterine fibroid. General examination is otherwise negative. Temperature on admission was 100. Moderate irregular fever, not higher than 102, continued for eight days after which it was normal. Pulse rate varied from 80 to 110. During the first forty-eight hours of her stay in the hospital she had three chills. Examination of the blood showed a secondary anaemia, haemoglobin 69 per cent, red blood cells 4,888,000. The leucocyte count on admission was 38,400, color index 7, polymorphonuclears 86 per cent, small mononuclears 10 per cent, large mononuclears 2 per cent. Four days later the white blood count had dropped to 19,800. Several other white cell counts varied between the two noted. A blood culture remained sterile after four days. Repeated urinalysis showed a persistent cloud of albumin with occasional granular casts and pyuria (50 to 100 pus cells per high powered field). The X-ray study was made by Doctor Manges who reported as follows: "From the radiographs alone the evidence favors the mass being spleen. If you permit we would advise a gastro-intestinal meal so that we may tell by displaced organs the definite location of the lesion." The report

continues after the ingestion of the gastro-intestinal meal "The mass in the left upper quadrant is of splenic origin This seems clear both by the displacement of the splenic flexure of the colon and also the elevation of the left diaphragm We are unable to tell the cause of the enlargement"

Operation October 3 The abdomen was opened through a left upper rectus incision under gas-oxygen anæsthesia Before breaking into the inflamed mass in the splenic region, the general cavity was explored Stones were found in the gall-bladder and a



FIG 2 —The case on the left has been cured The other is a case before operation (Wallace)

moderately large fibroid of the uterus was also found The splenic area was then packed off with gauze and a number of dense adhesions about the anterior surface of the spleen and its lower pole were separated The abscess in and about the spleen was then opened and about six ounces of pus evacuated The cavity was drained with rubber covered gauze drains around which the incision was partially closed Culture from the pus showed staphylococcus pyogenes aureus The day after operation her temperature was 101.3, pulse 100 Temperature became normal on the third day after operation and the patient made an uneventful recovery She was discharged from the hospital on the 28th of November Cause of the abscess is obscure Doctor Klopp feels that a probable source was the urinary tract infection

CASE III —A man, white, thirty-five years of age, was admitted on October 29, 1926, to the Pennsylvania Hospital

on the surgical service of Doctor Gibbon, to whom I am very grateful for the privilege of operating upon and reporting this case He had typhoid fever at the age of ten and was operated upon for hemorrhoids four years ago He suffered frequent attacks of tonsillitis until tonsils were removed three years ago Two weeks before entering the hospital he developed a carbuncle on the back of his neck which was incised a week later This improved and he felt better until two days before admission when he was suddenly seized with severe pain in the left hypochondrium radiating along the costal margin to the back, associated with fever, chills and sweats There was no nausea or vomiting Deep breathing, coughing and moving around in bed aggravated the pain which was continuous He was not constipated and there were no symptoms referable to the genito-urinary tract Physical examination reveals a recently incised healing carbuncle on the back of his neck Respiratory movements were restricted particularly on the left side Lung expansion was poor, there was slight suppression of breath sounds at the left base,

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but nothing else abnormal was noted on percussion or auscultation of the chest. The abdomen was somewhat distended. There was marked muscular rigidity and tenderness in the upper left quadrant. A palpable, rounded, tender mass, presumably spleen, extending three or four centimetres below the left costal margin was present. This represented the most tender area. Tenderness, however, extended around the costal margin to the loin and back. There was a marked increase in the area of splenic dullness to percussion which provoked pain. The liver was palpable but not tender, peristalsis was normal and general examination was otherwise negative. Temperature was 101, pulse 104, respirations 20, leucocyte count 34,000, hæmoglobin 90, red cells 6,260,000. Diagnosis of abscess of the spleen was made by Doctor Parker, the chief resident physician.

On the day after admission, the leucocyte count was 42,600 (Polymorphonuclears 80 per cent, lymphocytes 17 per cent, mononuclears 2 per cent, eosinophils 1 per cent). The temperature, however, was lower and for the next two weeks remained below 100 and near normal most of the time with a pulse rate of 80 to 90. There was a gradual reduction in leucocytosis to 12,000, and a diminution in the size of the mass with much less pain and tenderness. An apparent improvement in the patient's general condition led us to believe that the infection was subsiding and made us doubt the correctness of the admission diagnosis of abscess of the spleen. We were further convinced of this by our observation of the next ten days

which carried us to his twenty-third day in the hospital and the twenty-fifth day of his illness. Our false sense of security was then much disturbed by recurrence of pain, increased fever (101) and leucocytosis of 33,000 (Polymorphonuclears 82 per cent, large lymphocytes 4, white lymphocytes 9, transitionals 2, large mononuclears 3). At this time he developed a slight dry cough with a few râles and a definite friction rub in the lower left chest anteriorly. Repeated examinations had not revealed any abnormal findings in the urine, Wassermann reaction was negative, blood culture was sterile, blood chemistry was normal, (sugar 96, creatin 1.3, urea nitrogen 8.2). Culture of pus from the discharging carbuncle showed the presence of *staphylococcus pyogenes aureus*. October 26, the leucocyte count was 50,500. During the three or four days following this high leucocyte count there was a reduction in fever and leucocytosis to 21,000 with a lowering of the



FIG 3—Primitive, but effective method of drainage by stab wound and inserting of rubber tubing

pulse rate and apparent improvement again in the patient's general condition. There was no evidence of further pleural or pulmonary involvement.

Operation was done December 3, under morphia, gas, oxygen anesthesia. The abdomen was opened through a left upper rectus incision and the spleen, much enlarged, was found extending to the level of the umbilicus and surrounded by adhesions. Protecting the general cavity with gauze, the adhesions between the abdominal wall and surface of the spleen were partially separated and the abscess, which had ruptured through the capsule, was opened, discharging about 250 c.c. of reddish-yellow pus. This extended deeply into the splenic substance of the lower pole. A vasclimized gauze pack used as a drain, around which the wound was partially closed, controlled the slight bleeding from the walls of the abscess. The patient's condition was good at the conclusion of the operation

and the temperature was normal four days later. The gauze pack was gradually removed and the wound discharged freely for about three weeks. Culture from pus showed staphylococcus pyogenes aureus in pure culture. The wound healed slowly but satisfactorily and he was dismissed from the hospital 58 days after operation. At this time leucocyte count was 11,500 and his blood picture, which has been followed with frequent examinations for more than a year since operation, failed to disclose any abnormalities in the character or number of platelets, white or red cells. The probable source of infection was the carbuncle, as the same type of organism was recovered from both suppurating foci. In retrospect



FIG. 4—Showing elevation of left diaphragm before drainage of abscess

we criticize our delay in surgical intervention, as the conditions were obvious from the standpoint of diagnosis and the indications were definite for early operation.

The causes of abscess of the spleen are numerous but its development depends almost invariably on the deposit by the blood-stream of pyogenic organisms from some primary source of infection. The source may be a suppurating focus, obvious or concealed in any part of the body. This is shown in the great variety of attributed causes in the reported cases. The condition most frequently occurs where there is a general blood-stream invasion by pus producing organisms, and the infection has reached the magnitude of a septicopyemia such as is observed in the cases of acute ulcerative endocarditis and other virulent generalized infections most commonly caused by streptococci and staphylococci. Almost all of the pyogenic organisms are represented as causative agents.

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W D Inlow, who in 1927 collected 23 cases of traumatic origin, reporting one of his own, states that 15 per cent are due to trauma. Many of the acute infectious diseases have been assigned as a cause of splenic suppuration, —influenza, small-pox, rheumatic fever, etc., while certain of the specific fevers play a special rôle in the etiology of abscess formation in the spleen. This is particularly true of enteric, and to a lesser extent of typhus and relapsing fevers. None of the recently reported cases have been attributed to malaria, which Kuttner and the earlier writers ranked next to typhoid. Chowdhooray noted the occurrence of three cases of abscess of the spleen in 30,000 cases of malaria. Kuttner reported in 1907 twenty-five instances supposedly due to malaria and since then three cases of malarial origin have been recorded. Nearly all resulting from malaria were observed in India, Italy and South Africa. Typhoid, which is accredited by various authors, (Kuttner, Morel, Sabrazes) as causing about 14 per cent of the cases, and acute vegetative endocarditis, are undoubtedly the most common single causes. Merklen reported a case due to para-typhoid infection. Montel's case was due to an atypical para-typhoid bacillus, both terminating fatally.



FIG 5 —Elevation of left diaphragm less marked, about two weeks after operation

In a review of 3600 autopsies at the Pennsylvania Hospital we found twenty-four instances of abscess of the spleen, thirteen in males and eleven in females of an average age of twenty-eight years. An ante-mortem diagnosis of abscess of the spleen had not been recorded in any case and in nine instances abscess was found associated with acute ulcerative endocarditis. These cannot be regarded with great importance from a surgical standpoint as in none of them were there any symptoms or signs recorded, prior to death, which would have led to or even suggested a diagnosis of abscess of the spleen. Furthermore, whether or not recognized, it is a late complication of a malady in itself almost invariably fatal. In most of these cases, as in several of the others dying from various causes there was positive blood-stream infection and toxemia of such a marked degree that any significant localizing symptoms of splenic abscess probably would have been obscured.

In nearly all of them multiple abscesses were found associated with abscesses of the same character in liver, kidneys and lungs

In five cases abscess was found in association with acute peritonitis the result of streptococcic or staphylococcic pelvic infection. In three, the abscesses were multiple, in the other two they were small and solitary and in none were there any symptoms recorded suggestive of splenic inflammation. It was noted in three of these cases that there was no tenderness or enlargement of the spleen found on examination shortly before death.

Abscesses occurred in three of the subjects as a complication of typhoid fever and these are more interesting from a surgical standpoint than those already considered.



FIG 6—Left diaphragm about normal one year after operation

fifteen days when the patient suddenly died while sitting up on a back rest. Autopsy showed an abscess of the spleen with a sub-diaphragmatic abscess and dilatation of right ventricle and auricle as the probable immediate cause of death.

Another patient was admitted on the fifth day of his typhoid infection with a positive widal, a negative blood culture and leucocyte count of 3,800 and severe toxemia. Temperature was about normal on the 23rd day of the disease and remained so for about a week when it became elevated, irregular and associated with chills, sweats and signs of pleurisy and accumulation of fluid in the left chest with a leucocyte count of 19,900. Prior to this a few râles had been heard on both sides. Two days later the left pleural cavity was aspirated and 200 c.c. of reddish-brown fluid was withdrawn. A thoracotomy with rib resection and drainage of the pleura was done. A considerable quantity of reddish-brown purulent fluid escaped. The abdomen was not distended and not tender. The patient succumbed two days later. Autopsy revealed an abscess of the spleen, an abscess of the left lung and necrosis of the left diaphragm. Culture from the abscess cavity showed typhoid bacilli.

The third case concerns a man who had been ill for five weeks before entering the hospital and it was thought he was suffering from a relapse of typhoid. On the day

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before admission he was suddenly seized with acute abdominal pain and vomiting. He was admitted in a state of shock, his extremities were cold and his pulse barely perceptible. He had two very small hemorrhages from the bowel shortly after admission. The abdomen was fairly soft and the abdominal muscles were well moved in respiration, especially in the upper half. The spleen was not palpable or tender. Heart sounds were clear but weak, breath sounds were exaggerated over the left base. The patient hic-coughed and had violent paroxysmal contractions which resulted in vomiting at five minute intervals. The vomitus had a fecal odor. Widal reaction was suggestive and leucocyte count was 34,800. On the day after admission an exploratory abdominal section was done and the findings recorded were as follows: "no peritonitis found, the appendix, gall-bladder, pancreas, liver and spleen felt normal, no distention of the organs, color of the intestines was good and there was no obstruction. The abdomen was closed. The patient died four and a half hours later." Autopsy revealed acute phlegmonous gastritis with exudate in the duodenum and ilium, healing typhoid ulcers in the ilium, abscess of the spleen and thrombosis of the aorta at its bifurcation.

Suppurative appendicitis was the antecedent infection in two cases. In one instance a girl of fourteen was admitted and operated upon three days after the onset of an acute suppurative appendicitis with peritonitis. The appendix was removed and drainage established. Four days later there were signs of a left basal pleurisy and extending peritoneal infection. Death occurred ten days after operation. Autopsy revealed acute generalized peritonitis, multiple abscesses of kidneys and spleen (Several scattered throughout its substance).

In contrast to this example of pyemic multiple abscess formation, a part of a terminal infection, the other case followed more than a year after a drainage operation for appendicitis, where there was a persistent sinus until shortly before the sudden onset of the fatal illness. It was characterized by sharp low precordial pain aggravated by sneezing and coughing with the development of a left basal pleurisy. Spleen was enlarged to percussion and there was marked tenderness in the splenic area. Illness was progressive with chills and fever which was fluctuating and high (103-104). A pleural effusion was present and 400 cc of fluid was aspirated. A diphtheroid bacillus was grown on culture from fluid aspirated. Wassermann negative, blood culture negative, leucocytes 11,000 to 12,000. Autopsy disclosed chronic abscess of the spleen with sub-diaphragmatic abscess, peritonitis, multiple abscesses of the liver, pleurisy and atelectasis of base of left lung.

The other cases represent various etiological factors, one resulted from a staphylococcus pyogenes aureus infection of the upper lip with septicæmia, one followed suppurative cholecystitis with liver abscess. In another instance a large abdominal abscess in the lower left quadrant, supposedly resulting from diverticulitis or cancer of the sigmoid, was incised and drained. The patient improved, left the hospital with a discharging sinus but was later readmitted and the condition diagnosed clinically as cancer with metastasis to lungs as shown by X-ray examination. The terminal illness was of a septic character associated with chills, sweats and fever of an irregular type. The entire process, as shown at autopsy was due to actinomycotic infection, resulting in extensive invasion of lungs, liver and spleen in which there were

large areas of necrosis with central abscess formation. All organs showed typical bluish black pigmentation so often seen in actinomycotic infection.

In still another case we have an example of infection of the spleen with abscess formation by propagation, the result of perforation of the stomach. A large abscess had formed in the under surface of the spleen and adjacent to the greater curvature near the cardia which was the site of an ulcerating cancer.

In the last case the source of infection was not determined or even suggested by the history. The patient on admission was regarded as a case of generalized peritonitis too ill for operation. Tenderness and pain was most marked in the left hypochondriac region. There were signs of a left basal pleuro-pulmonary involvement and a loud to and fro friction rub was heard over the lower left chest anteriorly. At autopsy there was found a splenic and peri-splenic abscess which had ruptured resulting in peritonitis. Multiple abscesses were also present in the liver. Culture from the abscess of the spleen showed colon bacillus and streptococci. Twenty years before he had had typhoid fever.

Infarction of the spleen was found in 141 instances of the 3600 autopsies. Two hundred and five of the examinations were done on subjects dead of typhoid fever. Nineteen showed infarction of the spleen and in three others abscesses were found from which typhoid bacilli were recovered.

Krumbhaar, in a study of 5,000 postmortem examinations, found thirteen cases of abscess of the spleen and splenic infarction in 202 instances. Certainly any acute infection, carrying with it a high incidence of infarction, as noted in some of the aforementioned specific fevers, where there is a primary bacterial invasion of the spleen, also incurs an increased liability to splenic suppuration.

A. F. Wallace reported in 1922 a remarkable and unique experience from Broken Hill, Northern Rhodesia district, South Africa, where in the two preceding years he had seen forty-nine cases of abscess of the spleen, having operated upon nineteen of them. The other thirty were either not diagnosed until after death, or more usually, had died outside the hospital and their bodies were sent to the mortuary for examination. He had worked in this locality for twelve years without observing a case until the last two years of his service. He maintains the cause is obscure, but is inclined to look upon the infection, which frequently leads to thrombosis of the leg, mesenteric and cerebral veins, as some new disease or possibly a manifestation of influenza which is very prevalent and endemic among the natives, or a peculiar type of relapsing fever. The only organism reported is a spore bearing, gas producing bacillus. In these cases the onset is sudden with high temperature, headache and distributed pains in the neck and body. General symptoms usually subside in three or four days followed by pain in the spleen which rapidly enlarges and becomes tender. Operation reveals a large abscess filled with chocolate brown pus and foul smelling gas. He has drained nineteen cases through vertical abdominal incision with fifteen recoveries.

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In a personal communication from Doctor Wallace dated April 13, 1928, he makes the following statements concerning his series of cases, a part of which was previously reported in the *South African Medical Journal*

"Altogether I have either operated on or found at postmortem well over one hundred cases of splenic abscess all similar to those described. No further clue has been found as to their etiology. A Belgian doctor in the Congo, (north of here,) published a series of four cases identical with mine, so the abscesses are not purely local. My opinion is that there is a disease endemic in Broken Hill which resembles influenza. A complication of this disease is thrombosis. This occurs in order of frequency in

(1) Leg veins leading to leg œdema

(2) In the spleen leading to infarction, and if this infarction becomes secondarily infected with gas-forming organisms from the intestine a splenic abscess of our local variety develops

(3) Thrombosis of the axillary veins with œdema of arm

(4) Cerebral thrombosis

(5) Thrombosis of the cavernous sinus

(6) Thrombosis of the mesenteric veins

The thrombosis is a venous one. There is never any sign of endocarditis postmortem."

Elting maintains that most abscesses of the spleen result from the breaking down of infected infarcts. This seems to have been the mode of development most frequently noted in the Pennsylvania Hospital series, and in several instances where multiple abscesses were present, other infarcts were observed in various early stages of suppuration. This process of degeneration or sphacelic separation of the infarct explains, according to most authorities the occurrence of the "sequestering abscess" described by Kuttner, where fragments of spleen of variable size are cast loose into the abscess cavity. This type, according to Kuttner, represents about 37 per cent of all abscesses of the spleen. It appears in an autopsy series that multiple abscesses are more frequently found than the solitary variety which are larger and usually more deeply situated. Kumbhaar found multiple abscesses in ten of his thirteen cases, we noted fifteen in twenty-four instances. Clinically a single abscess is usually found.

The symptoms of abscess of the spleen are exceedingly variable in character and intensity. In some instances the manifestations that might be considered more or less typical are overshadowed or altogether obscured by the associated infection of which suppuration in the spleen is only a complication. Its course may be acute, subacute or chronic and the symptoms will be more or less pronounced accordingly, depending somewhat upon the etiological factor. Of the causes, typhoid fever probably influences more strikingly the course and character of symptoms than any other infection. In some instances abscess may develop during or follow closely upon the primary infection. More commonly there is an interval of a few weeks or months before suppuration takes place. It is sometimes mistaken for a

relapse In exceptional cases, the signs of abscess formation may not be manifested for many months or years after the attack of typhoid In Abadie's case it was twenty months, in that of Stulz, five years Brown's case was even more singular A girl had an attack of typhoid at the age of twelve after which she suffered intermittent pains in the splenic region, dying at the age of thirty-one from an enormous abscess of the spleen which had ruptured into the colon

Local symptoms may be so mild as to be overlooked Fauntleroy and Propping reported absence of pain in their cases In other instances the symptoms are very pronounced from the beginning In the more severe pyemic infections, the development of an abscess in the spleen may add little or nothing to the picture of a condition in itself probably fatal

Abscess deeply situated and not involving the capsule will produce little or no pain and its development may only be accompanied by the general symptoms of suppuration, such as septic fever, chills, sweats and leucocytosis As the evolution of the abscess progresses from the upper pole toward the thorax, or from the lower pole toward the general peritoneum, symptoms of a pleuro-pulmonary or abdominal nature will develop When its extension is toward the thorax there will be diaphragmatic and pleural involvement characterized by pain of varying intensity, located in the left hypochondrium and lower thorax, radiating to the back and sometimes to the left shoulder The signs at first are those of a dry left basal pleurisy which may culminate in a serous, hemorrhagic, or purulent effusion This may be due to rupture of the abscess through the diaphragm When empyema is a complication, its cause, abscess of the spleen, may not be revealed until necropsy

Rupture into a bronchus has been reported Abscess formation in the anterior surface or lower pole will give rise to symptoms of an abdominal character If the abscess is walled off, the symptoms may be localized and confined to the upper left quadrant, characterized by pain, tenderness, muscular rigidity and signs of splenic enlargement with or without nausea and vomiting, otherwise a generalized peritonitis may rapidly ensue The spleen is always enlarged and the degree of enlargement will depend upon the extent of the inflammation In several of the reported cases the abscess has pointed in the loin Rupture has taken place into the stomach and colon and a fecal fistula has been established through the thorax

The signs and symptoms upon which one must depend for diagnosis are fickle Frequently the condition is not recognized until autopsy because of its inconstant clinical manifestations Pain, of varying intensity, is nearly always present Fever may be moderate, continuous or intermittent, is sometimes absent, but is usually suggestive of suppuration and in the severe cases is characterized by marked remissions associated with chills and sweats Leucocytosis may be absent, is usually higher than in most suppurative conditions and may exceed 50,000 Marked emaciation has been emphasized in several of the reports

Enlargement of the spleen is of diagnostic value only in conjunction with

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other symptoms of suppuration. X-ray examination is of great diagnostic value. Elevation and fixation of the left diaphragm is very suggestive and is a constant finding where the infection has extended to the subphrenic space, as is usually the case in abscess of the upper pole. A chronic abscess may be shown and the spleen can be outlined after the administration of a gastrointestinal meal by displacement of other organs. Exploratory puncture is a valuable aid to diagnosis and may give the needed information in a doubtful case. It has been condemned by a few, but is advocated by most writers.

The surgical treatment of abscess of the spleen is either splenotomy or splenectomy. In a review of the cases treated surgically, one finds that in the greatest number the procedure employed was splenotomy. Surgical approach to the abscess, as pointed out by Elting, may be gained through one of three routes: (1) trans-pleural, (2) abdominal, (3) retro-peritoneal. The avenue chosen will depend upon the direction of the abscess invasion, which is often toward the thorax and will indicate trans-pleural or trans-diaphragmatic approach. Abscess situated in the anterior surface or lower pole, will usually be more accessible through the abdomen. In exceptional instances pointing may take place in the loin, when access through the retro-peritoneal channel is preferable.

Finkelstein, in 1910, collected statistics for sixty-one splenotomies, with forty-eight recoveries and thirteen deaths, and eleven splenectomies with eight recoveries and three deaths.

With Lenormant et Seneque's group of twenty-seven cases reported in 1923, we have assembled twenty-eight other cases since 1907 including our own, which arrange themselves in the following order:

	Recoveries	Deaths	Total
Splenotomy	44	7	51
Avenue of approach			
Thoracic	13	2	15
Abdominal	29	5	34
Retro-peritoneal	2	0	2
Splenectomy	1	3	4

The operative mortality in the traumatic abscess according to Inlow is 38 per cent. Abscesses of typhoid origin give the best prognosis. Morel, Dambrie and Tapie collected thirteen typhoid cases with twelve recoveries (splenotomies) and one death (splenectomy). The outlook, so far as it concerns prognosis and treatment, will be regarded from the standpoint of the abscess and the condition with which it is associated.

Splenectomy, it would seem, is only indicated in rather exceptional instances where the organ is comparatively free from adhesions, the infection confined within its capsule and where removal can be effected without difficulty or danger of disseminating the infection. Usually by the time a diagnosis has been established, or surgical intervention practiced, the inflammation has already extended to adjacent structures causing secondary abscess formation and adhesions of a most formidable nature. Such a situation,

which is the rule, would render splenectomy a most difficult and dangerous procedure and splenotomy the easiest and safest operation

I am very grateful to Dr Wallace for the personal communication regarding his remarkable series of cases and for the photographs of patients before and after operation illustrating their appearance and his method of drainage

For the use of the autopsy and case records in this report, we wish to acknowledge our gratitude to Doctor Paul and the Medical and Surgical Staffs of the Pennsylvania Hospital

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- Chowdhooray Quoted from Elting
- Fauntleroy Quoted from Lenormant et Seneque
- Propping Quoted from Lenormant et Seneque

SPLENECTOMY IN EGYPT
BY JOSEPH COLT BLOODGOOD, M D
OF BALTIMORE, MD

DAVID I. MACHT, a graduate of the Johns Hopkins Medical School, and not only a well-known bio-chemist, but a scholar and student of Hebrew, sent me a very interesting reprint as a reminiscence of Dr. William J. Mayo's address before the students of the Johns Hopkins Medical School in January. Without doubt many of you are unfamiliar as I was that in ancient days spleens were extirpated in order to produce more fleet runners. Macht*—(Sonderdruck Aus Der Paul Haupt Festschrift, Leipzig, 1926, Vol. I, J. C. Hinrichsche Buchhandlung)—in the study of the Talmud in two places finds passages which suggest that the runners were all of them deprived of their spleen in order that they might run more efficiently. In a second place it is noted that the swift steeds are also described as having had their spleens extirpated in order that they might run the better.

Macht also states that a study of ancient and modern literature finds references concerning the relation of the spleen to running. In the Natural History of Pliny it is stated that runners in the race that are troubled with spleen have a device to burn and waste it with a hot iron. In Arabic literature there is the same—that a horse runs better without a spleen.

Splenomegaly in Egypt—When I was in Egypt in the early days of my medical career in 1893, I visited the great Government Hospital almost daily for ten days while I was in Cairo.

I was present at a number of autopsies and the portal vein was always opened as a routine to allow microscopic studies for bilharzia, which is probably a most common parasitic infection in this parasite-ridden country but I have no recollection of the condition of the spleens at these autopsies. Nothing then was known of the cause and cure of this infection. It was ravishing the Egyptians to the same extent the hook worm was infecting the people of the South in this country.

When I returned to Egypt in 1924, thirty-one years later, the cause and cure of this and other parasitic diseases had been well established. I witnessed in one day hundreds of Egyptians receive intravenous antimony which had been used in practice about three years. I found that in the Government Hospital and in the Christian Mission Hospital in Old Cairo there averaged about forty splenectomies more or less every year in each hospital. I learned

* Macht [The Effect of Splenectomy on Integration of Muscular Movements in the Rat (Reprinted from the *American Journal of Physiology*, vol. LVII, No. 3, November, 1922, p. 525)] made a series of experiments on rats, and noticed the difference between the splenectomized animals and the controls as they ran over a tight rope. The removal of the spleen did not interfere with the coordination of the muscles and the running of the animals. On the contrary it apparently improved the running speed.

that the operation was done under spinal anæsthesia, that the mortality was relatively low, and that when the patients recovered they were fully restored to their ability to work, not only because they had been relieved of the weight and pressure of the huge spleen in their abdominal cavities, but through medication, many different kinds of parasites and infecting organisms present in their tissues were destroyed

I cannot go into details as to the remarkable relation between surgery

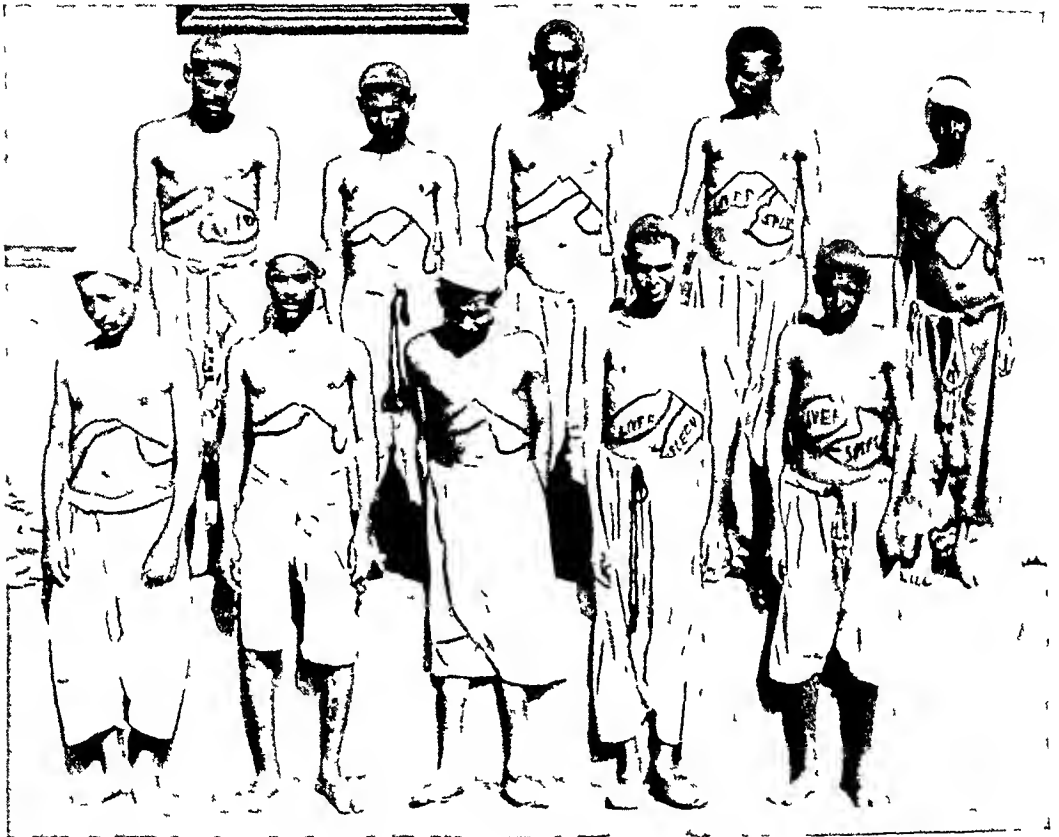


FIG 1—Photograph of a group of Egyptians with enlarged livers and spleens, outlined as they appear before operation

in Egypt and the predominant diseases. If the annual splenectomies are forty in a great hospital, the yearly appendectomies are three, and there is not one operation upon the gall-bladder or for duodenal ulcer in a year. Conditions due to over-burdening and over-work are the most common surgical conditions in Egypt—hemorrhoids, hernia, and varicose veins. Next to this ranks splenomegaly due to the heavy parasitic infections present in the inhabitants of the land of the Nile. According to all authorities bilharziasis and ankylostomiasis are present in 75 per cent of the inhabitants. Pellagra is very common, and one must always be on the lookout for syphilis. The malarial spleen is rare. Sir William Wilcocks, K C M G, in a reprint printed at the Nile Mission Press in Cairo in December, 1927, considers why cultivated Egypt is immune from malaria. The practical point is that Egypt above the Delta is immune from malaria, and even in the Delta it is not so common under certain conditions.

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When this subject was chosen for the chief topic at this meeting of the American Surgical Association I immediately wrote to a number of surgeons whom I had met in Cairo to get data. Just as answers were received I had the good fortune to be visited by Mr H E Stiven, principal medical officer of the Egyptian Government at Port Said, who had with him his paper soon to be delivered on Splenectomy for Egyptian Splenomegaly, and this young surgeon has had the remarkable experience of two hundred and eighty-five



FIG. 2.—Three Egyptians back at work on sugar cane after successful splenectomy.

cases in six years, which would be about forty-six cases a year and corresponds with the annual number of removal of spleens in the two larger hospitals in Cairo. At the same time I received a letter from Dr Robert Dolbey who for a number of years was professor of surgery in the Government Hospital at Cairo, so he is very familiar with the details of that operation as performed by the English and Egyptian surgeons. Then there is a full report from Dr J E Bateman, chief surgeon and operator of the Christian Mission Hospital in Old Cairo. These three papers, giving complete data

of the three largest hospitals in Egypt, allow me to give you a brief picture of their results and their methods. There seems no question that the surgeons in Egypt are having the largest experience annually except, perhaps, in the Mayo clinic, and apparently they are dealing with a type of individuals whose

vitality is tremendously reduced and a type of spleen very difficult to remove because of extensive adhesions.

The reports from other surgeons—English and Egyptian—in Egypt have not been received in time to incorporate them in this paper, nor am I able to give as I hoped a résumé of splenomegaly in oriental countries.

Pre-operative Preparation—Dolbey, whose experience was in the Kasr el Ainy Government Hospital in Egypt, writes that they pick and choose their cases and as a rule operate only upon those who are physically fit. Bateman from the Christian Mission Hospital in Old Cairo does not go into this point. Stiven, however, looking upon splenectomy as an extremely dangerous procedure, and upon the human material to work on as of a very unhealthy nature, describes in detail pre-operative treatment which requires about six weeks in the hospital. As a matter of routine every patient is given a dose of carbon tetrachloride for the ankylostomiasis, and a full course of tartar emetic by intravenous injection



FIG 3—Edema of the limbs, ascites, contraindicate splenectomy

every two days for twelve injections. This of course for the bilharziasis and then every patient receives six injections of 606.

The intestinal track is cleaned and kept clean by daily mixture of rhubarb and soda for the first week. The patients receive a tonic of iron and arsenic, and in addition to the best and most nourishing food, they receive beans which have been allowed to germinate in water for forty-eight hours. This bean soup is apparently specific for pellagra, and others suffering from some vitamin deficient.

Here in the Government Hospital on the Suez Canal these Egyptians have

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the benefit of a splendidly trained surgeon in a well organized and equipped hospital, apparently equal to the two great hospitals in Cairo, and during this pre-operative careful treatment all the laboratory investigations are made

All three surgeons are of the opinion that œdema of the limbs and ascites contraindicate operations. These three surgeons have not used blood transfusions before, during or after operations except Bateman who is employing an unusual and very economical method, mentioned in *Caeson's Operative Surgery*, where he takes the blood from the removed spleen. I will discuss this later. They all give the evening before operation a purge and an injection of pneumococcic vaccine.

The winter nights in Egypt are cold. The hospitals are not heated and all surgeons fear pneumonia. After operation the only method of warming the patient is to surround the bed by series of electric bulbs, which is really a very efficient method.

Operation—All use spinal anæsthesia. Bateman gives a hypodermic injection of morphia and hyoscine, and then about 0.6 gram of stovaine in a hypertonic saline solution. The needle is inserted between the eleventh and twelfth vertebræ. When the anæsthesia does not extend high enough it is combined with local anæsthesia in the skin and muscle. When the spleen is dislocated and delivered and the patients complain of pain they are given a little light chloroform or ether on an open mask. Dolbey reports that he performs splenectomy under spinal anæsthesia. Stiven gives morphia and atropine one-half hour before the operation. He describes the spinal anæsthesia as follows. The patient sits on the operating table and places his hands over his ears and bends down his head. He uses a two c.c. syringe and a long fine needle, taps the spinal fluid through the eleventh dorsal space, allows no fluid to escape, injects stovaine of the formula of stovaine bouillon of Poylenc Freres. In the Government Hospital in Cairo when I was there in 1924 I saw Mr. Maddon, who was then professor of surgery, perform a number of operations under spinal anæsthesia. It was very simply and quickly done as described here by Mr. Stiven. No general anæsthesia was given, but unfortunately there were no splenectomies during the days I was able to come to the operating room.

Position of Patient—Stiven allows his patient to lie on his back and does not raise the legs or lower the head. It is his opinion that this prevents headaches. Now and then he may give a little chloroform.

Incision—Bateman makes an incision in the left rectus with the addition of an incision in the line of the lower border of the ribs, extending from the top of the main incision superiorly and medially down to, but not through the muscle fibres. This allows a greater widening of the infracostal angle. Stiven stands to the right hand side of the patient and makes an incision varying in length according to the size of the spleen. This incision starts at the costal margin, runs parallel to the midline, divides the left rectus muscle into two equal parts.

Intra-abdominal Manipulation—Stiven describes this somewhat as fol-

lows After the peritoneum has been opened the exciting part of the operation follows The whole hand is inserted within the abdomen to find out what adhesions are present because the difficulties depend upon the adhesions which cannot be foretold When there are no adhesions the whole spleen is delivered Stiven has ready a dozen big clamps and he applies them to the whole pedicle of the splenic artery and vein, three or four clamps in juxtaposition, then he cuts off the spleen between the third and fourth clamp The pedicle is transfixed with a long pedicle needle Stiven has learned this trick from DeMartel of Paris The needle is threaded with a black and white linen thread Linen is preferred as its knot is less apt to slip than silk Black and white threads allow you at a glance to know whether the ligatures are inter-locked or not

The first ligature is put in the space revealed by releasing number two clamp, and as it is tied number one clamp is released and allows it to be tied tight Another ligature is then tied around the whole pedicle in position of number one clamp, and then a third is tied in place of number three clamp Various modifications of this procedure will have to be undertaken according to the circumstances Very frequently there is a big vessel running from the greater curvature of the stomach to the hilus of the spleen He picks up the lesser omentum and ties it off, and thus exposes the true pedicle of the spleen

Frequently there is a very strong adhesion from the splenic flexure of the large intestine to the spleen, and sometimes there are strong adhesions between the spleen and the under surface of the diaphragm These have to be broken with the fingers and after the removal of the spleen an assistant puts in a wide retractor and the bleeding points are clamped and tied He takes care to stop every bleeding point Stiven, you will observe, describes in great detail the ligation of the pedicle, but does not describe the exact manner in which he attacks the adhesions He told me however that he clamps and ties the adhesions and delivers the spleen just as quickly as he can, and fixes the pedicle with the clamp just as quickly as he can Dolbey writes that the huge vascular adhesions between the spleen and the diaphragm are carefully ligated before the spleen is removed He looks upon these adhesions as the chief difficulties Dolbey clamps and ties the splenic artery by opening into the lesser sac of the peritoneal cavity, thereby separating the splenic vessels from the tail of the pancreas Bateman writes that after the abdomen is open the vascular omental adhesions are inspected and as many of those adhesions as can be reached are divided and tied before the spleen is delivered He is of the opinion it is better to tie than to leave clamps on On the gastro-splenic omentum he prefers double ligature and division if possible before the delivery of the spleen, but this step may have to be delayed

Adhesions between the spleen and the diaphragm always have to be broken down, but they are seldom very vascular and are separated with ease

As soon as the spleen is delivered a mop is inserted in the splenic bed If the gastro-splenic omentum has not been divided as already described it is

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now dealt with, then a stout silk ligature is thrown around the vascular pedicle and spleen but this ligature is not yet tied. The vessel between the spleen, and the stomach at the superior angle of the gastrosplenic omentum is doubly ligated and divided. All remaining omental adhesions are tied off. The spleen is rotated forward if necessary. Bateman has not found it possible to ligate the main vessels from the lateral aspect in the big spleen. Sometimes he separates veins from arteries near the spleen and then applies ligatures, but more often like Stiven he doubly clamps the pedicles and divides. In removing the spleen there may be a few remaining adhesions to be clamped and tied. When a clamp has been used on the pedicle the separate vessels are tied before the loose common ligature is tightened and before the clamp is removed. If all the adhesions but the diaphragmatic have been clamped and ligated before division there is very little oozing in the spleen bed. The rent in the lesser sac is repaired.

Closure of the Wound—All three surgeons close without drainage.

Post-operative Treatment—Bateman in some instances removes the clamp from the spleen and drains the blood into a 3 to 8 per cent of sodium citrate solution. He has had three cases. He was able to inject into the patient's vein from 200 to 500 c.c. of the blood obtained from his own spleen. He proposes to continue this practice. He also admits that he might have saved some of his patients if he had given blood transfusions before operation, but he remarks it is difficult to obtain donors in Egypt. This of course is a matter of education, and I feel certain the Egyptians will quickly understand the value of blood transfusions as the people in other countries have. Stiven is of the opinion that these patients should be left absolutely alone. He is afraid blood transfusions will start oozing and hemorrhage. He does not give any water by mouth for twelve hours, nor even saline solutions, later he begins water and for five days a strictly fever diet. Robert V. Dolbey published some notes on blood transfusions in Egypt in the *Lancet*, for September 13, 1924, page 547, and reports forty-two blood transfusions in four years, in thirty the whole blood method, and in twelve the citrate method. These blood transfusions were performed for primary hemorrhage, secondary anemia, and in a few instances preparatory for operations upon individuals suffering with marked anemia from ankylostomiasis and bilharziasis. They have demonstrated among the Egyptians the importance of blood grouping. The work was done by Dr. A. T. Shousha in the Seriological Department of the Government of Egypt. This student found that group four donors were low in proportion as compared to Europe, and he found there was no essential incompatibility in the bloods of the various races of men in Egypt.

Post-operative Mortality—Dolbey states "our mortality is still low." In the report of the Kasr el Any Hospital (Egyptian Hospital in Cairo) for 1923, which was presented to me by the Director, Dr. Saleh Hamdi, during my visit in January, 1925, I find there are recorded sixteen splenectomies for endemic splenomegaly with two deaths which is about 12 per

cent Of course this means deaths in hospitals During the same period there were two hundred and seventy-one operations for inguinal hernia with four deaths which is a little more than 2 per cent, and there were one hundred and twenty-three operations for hemorrhoids without a death There were thirty-one thyroidectomies with one death, about 3 per cent I find eighty-seven operations for stone in the bladder, fifty crushings, thirty-three supra-pubic and four peritoneal without a death Splenectomy then was the operation of highest mortality Stiven gives his mortality in great details For about nine hundred operations other than splenectomy the mortality is about 10 per cent, while the mortality in the hospital is 14 per cent, and much of this is pneumonia in spite of every precaution When he follows his cases—and he apparently has done this very thoroughly—the mortality increases to 24 per cent Sixty-four per cent are apparently well and able to work About 5 per cent are in poor or indifferent health The remarkable thing is he was able to trace all but 6 per cent

I think it is just to remark here that social service and follow-up is just about as good in the Delta region and perhaps better than in Europe and in this country The method is as follows Stiven sends a few questions to the Omdah or head man of the village and he through the police gets the reply These are the simple questions—"Is the patient still alive? Has he increased in weight? Does he feel better than before the operation?" Stiven remarks that when the patient dies the head man of the village reports with the most tactful remark "that he died of another disease" Stiven concludes that splenectomy is a dangerous operation requiring especially careful preparation first, but as improvement in general health can only be obtained by splenectomy the means justify the risk As far as I can make out the destruction of the organism of bilharzia by the intravenous injection of a solution of antimony has no effect upon the enlarged spleen Undoubtedly as more and more Egyptians come to the hospitals for treatment in earlier stages the number of enlarged spleens will be reduced

Dolbey writes "we believe that intravenous therapy in bilharzia is reducing the number of enlarged spleens"

The Cause of Splenomegaly in Egypt—Stiven is of the opinion that the causal factors are not yet definitely proved, but that the enlarged spleen is the result of heavy parasitic infection

Bateman is of the opinion that malaria is not a factor Dolbey still believes that "Egyptian Spleno-Megaly" is a bilharzial condition and is different from Banti's Disease The blood picture is different and they have never found the Leischman-Donovan bodies

The Spleen—Unfortunately Doctor Stiven brought with him only sections of the liver and not of the spleen, and up to the present time the specimens promised to me by Dolbey and Bateman have not been received, but in the majority of these spleens unless the patient has had a prolonged pre-operative treatment they find bilharzia ova

The Spleens of Mummies—Both Dolbey and Bateman confirm the impres-

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sion I got during my visit that the ova of bilharzia have been found in the spleens of mummies dating back to 2000 B C. These parasites can be brought out by the Armand Ruffer technic by soaking the spleen in glycerine and carbonate of soda. I had hoped to show you a section of a four thousand year old spleen with a parasite in it, but it is very difficult to send out of Egypt things of this kind.

I have not yet received the report of Dr. Georgia Subhy of the Kasr el Ainy Hospital who is the great authority on the special studies in mummies.

Ankylostomiasis and Bilharziasis in Egypt—I have before me the reports and notes of the Public Laboratory in Cairo. It is published by the Department of Public Health by the Minister of the Interior, and this report is dated 1924. Most of the articles are written by Dr. M. Khalil. There are also contributions by Dr. M. S. Abaza and Dr. A. T. Shousha. This book of almost two hundred pages, splendidly illustrated, is a complete study of these two parasitic infections, the life circle of the organism, just how it enters human beings and how they can be protected, and how the disease can be prevented. Tourists in Egypt run practically no risk of this infection if they are careful of what they eat and drink, and do not go wading bare-foot in irrigating ditches.

Prevention of the Enlargement of the Spleen in Egypt—This undoubtedly is on the way. When I was there in 1924 often five hundred Egyptians came to the hospital on one day for intravenous injection, and the probabilities are that from one hundred to one hundred and twenty seek help through splenectomy each year, but when the Egyptians are properly trained as to their drinking water and food, and how they should not expose their naked bodies to certain kind of drainage water they will neither require intravenous antimony nor splenectomy. Professor Wendell Cleland, Director of the Division of Extension of the American University at Cairo, has started an educational effort to teach the Egyptians village and personal health. I have before me a leaflet entitled "A Student Contest to Promote Village Health," and I am quoting from this interesting publication which demonstrates that the young Egyptians are learning the rules of health and also how to teach others. The following is a direct copy: "The winner of the first prize did his work in the small village of el Hagra in Sharqia Province, sixty-six miles north of Cairo. The population of this village is 2579 with 1672 others living on farms in the neighborhood. Although not himself a sheikh entitled to speak in the mosque, this student showed ingenuity in getting health subjects discussed in the places of prayer. To quote from his report: 'Friday, June 3rd, was the last Friday in Ramadan. I went to pray at the chief mosque of the village. After prayer the congregation dispersed quickly on account of the stuffy atmosphere inside. I managed however to hold a goodly number and asked them to listen to the circulars on water and flies. This took ten minutes. I noticed that they showed keen interest. Some of them asked "Is it harmful then to drink any water other than filtered water and pump water?"' I explained and they seemed satisfied. The first plunge and the

success it received made me optimistic. This however was cut off by some "Faqueehs" (blind chanters of Koran), who protested against talking on health subjects inside the mosque. They considered this as an interruption of the service and a heated argument followed. They accused me of not being a true Mohammedan, and that I was preparing the way for anti-Mohammedan propaganda, since these circulars were issued by a non-Islamic body. I had to be very patient and at the end succeeded in making a good number believe the importance of this work and its humanitarian object and was thus able to proceed without much resistance."

NOTE—It seems proper in this place to record my sincere thanks and appreciation to our surgical colleagues in Egypt, Doctors Bateman, Dolbey and Stiven, for the detailed description of their experience with splenectomy and for their photographs

DISCUSSION—SURGERY OF THE SPLEEN

DR ARTHUR D BEVAN, of Chicago, Ill, said that he and his associates had been doing most of this splenic work with ethylene, sometimes preceded by a quarter of a grain of morphine, associated with blocking the intercostal nerves on that side with novocaine, and where additional relaxation is needed during some short stage of the operation, possibly a few whiffs of ether

With regard to ethylene, nobody should use ethylene without taking the necessary very simple precautions to avoid static spark It costs about twenty-five to thirty dollars to buy a steel mat, ten by twelve feet in dimension, upon which should be placed the operating table and the gas machine The steel mat should be connected with the plumbing This eliminates, he believed they had demonstrated, entirely the danger of the static spark Of course, any individual who uses a cautery in the presence of ethylene or ether, where an explosion can occur, should be barred from the operating room

Ethylene acts admirably in the great majority of these cases He could not see any sound reason why spinal anæsthesia should be used in these cases, because the sequence of ethylene and ether has been so satisfactory in their experience

DR FRANK K BOLAND, of Atlanta, Ga, said that in addition to the splenomegalies, which had been under discussion, he would like to speak of the opposite kind of spleen, the spleen which is seen in cases of sickle-cell anæmia So far, there have been about eighty cases of sickle-cell anæmia reported in the literature Four have been recognized in Atlanta This disease is a familial disease, and so far has been found only in the negro or mulatto Five operations have been reported, with four recoveries and one death This one death was a case that was operated upon by the speaker It was a negro man, twenty-eight years of age, who had been sick about ten years He had the characteristic symptoms of the disease—weakness, attacks of abdominal pain referred to the left hypochondrium, and leg ulcers which were very difficult to heal These are outstanding characteristics of the disease, accompanied by the weakness and dyspnoea which go with most cases of anæmia A slide showing the spleen which was removed from this man was shown on the screen The spleen weighed fifteen grams, and was about 7 cm in length It was very difficult to remove, much harder to remove than a large spleen

The patient stood the operation well and left the table in good condition but he died about six hours later They were unable to obtain an autopsy The cause given for his death was embolism

It might be asked whether this was an accessory spleen on account of its small size, but this organ was in the exact anatomical location for the spleen, and he did not see how it could have been accessory The four other cases operated upon with recovery have shown an amelioration of the symptoms but not an entire cure

DISCUSSION

Of course, the most characteristic sign of this disease is the sickling of the blood. He then showed a second slide depicting another spleen which was removed at autopsy which is even smaller in size than the one which he removed, weighing about twelve grams. This was followed by a third slide



FIG 1—Spleen weighing 15 grams removed from case of sickle cell anemia

showing the blood with the sickling which is so characteristic of the condition. In his case about 20 per cent of the red cells showed sickling. The percentage of sickling in these cases runs from 2 to 50 per cent. In this man, the leucocyte count was 45,000, an average leucocyte count for this form of anæmia. He had 3,000,000 red cells and about 60 per cent hæmoglobin.

The only other disease in which he had been able to find a diminutive spleen like this is in leprosy in which a spleen removed at autopsy weighed only two and a half grams. He could not see how the removal of these diminutive organs can have much good effect on the patient. About half of these cases show a slightly enlarged spleen and about half an undersized spleen. It is believed that the diminutive spleen is found in a later stage of the disease.

DR WILLIAM D HAGGARD, of Nashville, Tenn., said there have been something less than one hundred cases of sickle-cell anæmia reported, about twelve of whom have had splenectomy. A very considerable majority of these have been greatly benefited if not entirely and completely cured. It occurs exclusively in the negro.

The characteristic of the disease, as they have observed it has been an anæmia of a secondary type, more or less grave, associated with abdominal pain, inflammation of the joints, and leg ulcer.

They have noticed the familial character of the disease, the hereditary character, and were interested to pursue some studies in regard to the occurrence of it in normal individuals.

Lawrence tested the blood of a hundred students and nurses at the Vanderbilt University and found 2 per cent of that number to have sickle cells. Then he studied another hundred colored people in the Meharry Medical College and found about 3 per cent showed these cells.

Among these patients who did not have typical sickle-cell anæmia, he encountered the cell in an elderly white woman who complained of inability to walk, which was really due to a hemiplegia. She did, however, have some

SURGERY OF THE SPLEEN

evidences of splenic anæmia and petechiæ. The interesting thing was that her sister and brother and one niece also had the sickle cell, but another brother and another sister did not have it.

DOCTOR HAGGARD then displayed on the screen slides showing a typical example of Bishop's drawing of the sickle cells. They are very typical, very unusual, and very bizarre. Elongated cells are in the same slide with sickle cells. Others have the sausage-shaped cell as well, and in one man who was perfectly well and healthy—a white man, too, were found sausage-shaped cells.

The sickle cell, the sausage type, and the filamental elongated variety are typical of this disease.

One of their splenectomies was in a woman sixty-two years of age who had splenomegalous leukemia with a white count of 144,000, but under radium it was reduced to 12,000. We were content with her improvement and did not consider splenectomy for the leukemia but she had such severe gall-stone attacks that they were obliged to operate for that and removed the spleen also and had the satisfaction of her being alive and well at the end of five years.

DR EUGENE H. POOL, of New York City, called attention to the bone involvement in Gaucher's disease.

The characteristic cells which are peculiar to this disease are distributed not only in the spleen but also in the liver, lymph-nodes and bone-marrow. Such wide distribution occasions uncertainty as to whether the condition should not be regarded as a systemic disease rather than a specific splenic lesion, and whether removal of the spleen influences the disease beyond the relief of the patient through the removal of the mass.

So few cases have been reported and followed (four years ago only about forty cases were on record), that the incidence of skeletal involvement and its effects are difficult to estimate. Yet Ludwig Pick, in a recent article on the bone lesions of Gaucher's disease, has reviewed the subject and states that the lower end of the femur and lower end of the tibia are the situations most often involved, but he cites involvement also of most of the other bones, for instance, the phalanges, sternum, ribs, skull, etc. He states that the lesions are first small foci of cells, and that these foci later coalesce, giving under the X-ray a peculiar mottling.

DOCTOR POOL related the history of a Jewish woman, twenty-five years of age, who was operated upon in January, 1921, and a spleen of over 3,000 grams removed. This showed the typical picture of Gaucher's disease, (*ANNALS OF SURGERY*, vol. LXXIV, 1921, p. 635). Since that time, over seven years, her health has been good with one exception.

Four years ago her left hip became painful. It was put in plaster in another hospital for six weeks and the joint is now immobile and painless. She has a decided limp. The blood shows slight secondary anæmia. The X-ray studies by Doctor Belden, of the New York Hospital, are of interest.

DISCUSSION

Examination of the skull and other bones shows no evidence of disease except in the left hip-joint, where there is a definite destructive process involving the head of the femur. The head is mottled in appearance and there is a definite bone absorption taking place, with the addition of some irregular calcification. The head is triangular in appearance. The greater trochanter shows a definite decalcifying process and the medullary substance in the shaft of this femur shows mottling for about two-thirds of the shaft. These changes were interpreted as involvement of the bone as the result of Gaucher's disease. This case will be carefully followed in the hope that it will be possible to report later significant developments.

DR MAX BALLIN, of Detroit, Mich., said he had had the opportunity to examine two patients with an unusual type of splenomegaly, one in Harper Hospital, and one the patient of a surgeon outside of Detroit. Both of these cases were operated upon and the spleen had been examined microscopically. The cases were both of middle-aged persons, one thirty-five years old, a woman, the other forty years old, a man. The splenic tumor had existed for thirty or more years, as long as they could remember. They had no special complaints except a tired feeling and the presence of a large splenic tumor. The red cell count was three and a half millions. There was no anæmia and no fever. There was a leucocytosis of 25 000, however, and nucleated reds up to 10 per cent and more. The spleen specimen showed very interesting cell enclosures, practically bone-marrow enclosures in the spleen, as will be seen in slides presented (Figs 1, 2, 3, and 4).

This type of splenomegaly is hard to understand and is most likely a congenital enclosure of aberrant bone-marrow cells in the spleen. Dr Phinn F. Morse, the pathologist at Harper Hospital, published these two cases with the speaker in the *Journal of the American Medical Association*, November 12, 1927, vol lxxxix, pp 1671-1672. He suggested the name "Myelophthisic Splenomegaly."

After operation the condition of the blood did not change at all. One patient has been observed for over eight years without any change in the general condition, the blood count staying exactly the same as before splenectomy.

DR DAVID CHEEVER, of Boston, Mass., made a suggestion in the field of technic. Reference had been made to the advisability of conserving the blood in the spleen by collecting it after its excision, citrating it, and reinfusing it. Now, in many cases of enlarged spleen it is quite possible to operate, to deliver the spleen, secure the arterial supply entirely separately, and then pick up the smaller branches until there is nothing left but the large splenic vein. The spleen is then held up and gentle pressure can be applied, if there are no bacteria or toxic products which might get into the circulation. Under these conditions the spleen shrinks in size beneath one's hands. Then after the vein is ligated and the spleen removed, there will be practically no bleeding from the pedicle. That is a very effective way in suitable cases of conserving all of the blood which otherwise might be lost.

SURGERY OF THE SPLEEN



FIG 1 —Low power Myeloid islands and bone marrow giant cells scattered throughout the splenic pulp

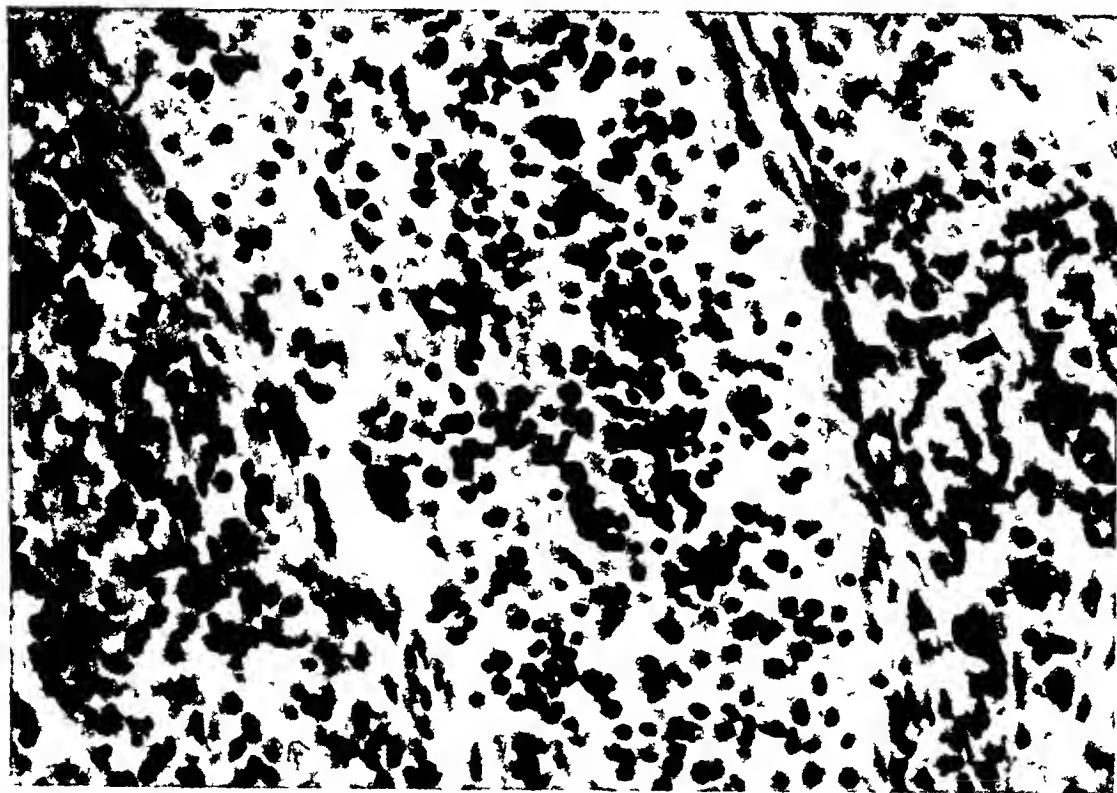


FIG 2 —Splenic vein showing large numbers of nucleated, immature cell types

DISCUSSION

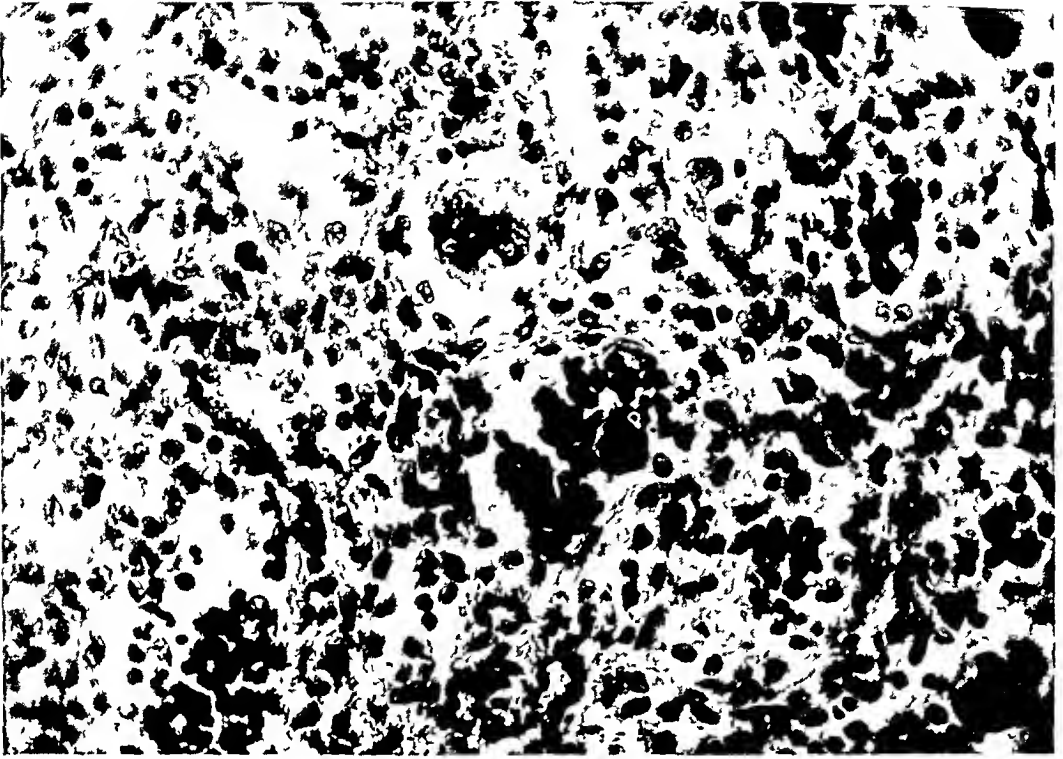


FIG 3—High power Bone marrow giant cells and myeloid areas in spleen sinuses

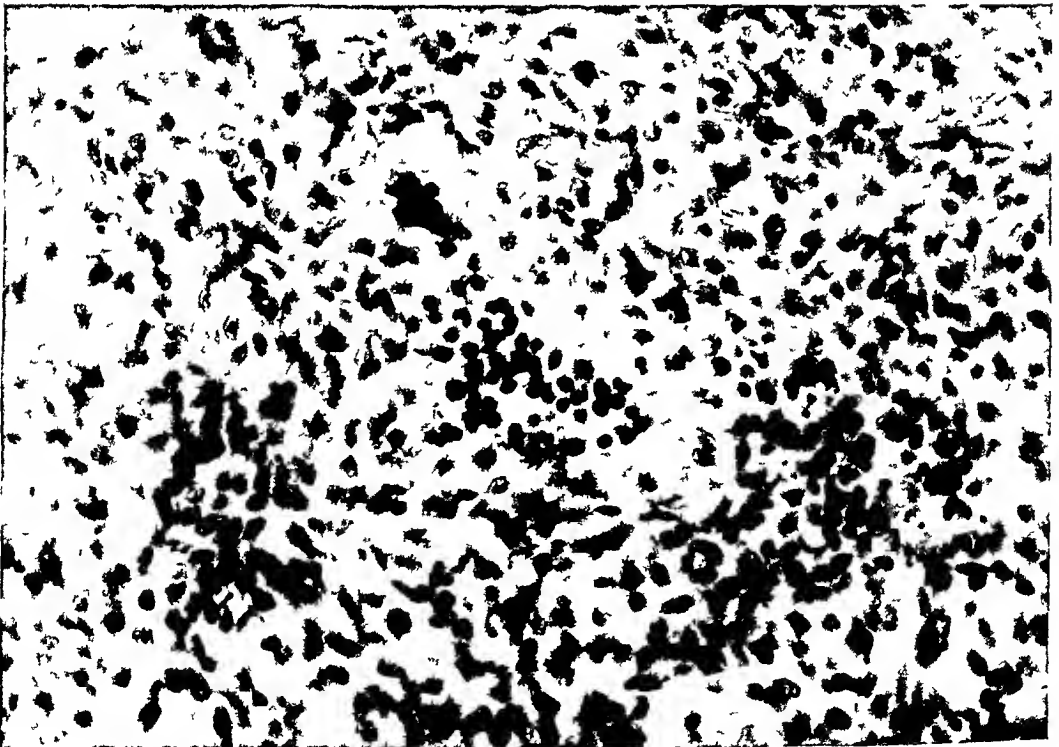


FIG 4—Myeloid areas in spleen sinuses

SURGERY OF THE SPLEEN

DR JOHN H JOPSON, of Philadelphia, Penna., said, with regard to the question of technic to which Doctor Cheever had alluded, he practiced in one case the reinjection of citrated blood after the spleen was removed. It was a pure afterthought, the spleen having been thrown into a sterile basin, and seeing a large amount of sterile blood which was being lost, he suggested that it be citrated and transfused, which was done.

Doctor Jopson remarked further that there is a type which has not been discussed here to-day, namely, malarial splenomegaly. He had had a case recently in an Armenian girl, seventeen years of age. Splenectomy for malaria is an unusual operation in the vicinity of Philadelphia. This girl contracted her malaria in Armenia, from which country she had fled recently, by reason of the massacres, to the United States. When she was admitted to the Presbyterian Hospital it was mainly because of symptoms which suggested cholecystitis to her physician, who was himself an Armenian, had practiced in that country and Persia, and was familiar with the type of splenomegaly which she presented. Her symptoms were strongly suggestive of cholecystitis in spite of her youth, and she had quite a marked but transient jaundice on her admission to the hospital. Operation was decided upon, the first search was made through a mid-line incision for disease in connection with the biliary passages. None being found and the liver being healthy, they removed the spleen, which weighed 460 grams, or about three times the normal size in the female. It presented the characteristic histology of the malarial spleen, according to Dr John A Eiman, the pathologist to the hospital. She made a smooth recovery, has gained in weight and is the picture of health.

Doctor Billings in his paper made reference to the operative technic in cases of abscess of the spleen and spoke of exploratory puncture. It seemed to the speaker that this should be reserved for abscesses arising from the upper pole, which is the most frequent type of solitary abscess. It is unfortunate that splenic abscess is so commonly simply a by-product in cases of pyemia. The abscesses are multiple and do not lend themselves to drainage, but occasionally solitary abscesses do occur as a result of hæmatogenous infection. When they are located in the upper pole and when they perforate the capsule and when, as they sometimes do, they give rise to subphrenic abscess, then the problem is similar to the common subphrenic abscess on the right side and then posterior aspiration is justifiable, and posterior approach and drainage are indicated.

DR WILLIAM J MAYO (in closing the discussion) mentioned some of the misfortunes that may come to those who remove the spleen, at least misfortunes that had come to him.

First, the surgeon must make up his mind before he starts whether or not he will take the spleen out. Once the operation is begun, there is no place to stop, because the blood vessels are underneath the spleen, and the hæmorrhage cannot be controlled until the spleen is out.

DISCUSSION

Before bringing the spleen to the outside of the abdomen, it is best first to free the spleen from all its attachments except the pedicle and push the spleen downward, as Doctor Balfour pointed out ten or twelve years ago, to prevent the jejunum from entering the splenic space. Then pack a large hot wet gauze roll into the splenic space to control the venous bleeding. As a rule, by the time one is ready to remove the pack, the bleeding will have stopped, but not always. In half a dozen cases at least he had been compelled to place and leave a large pack in the bleeding space. In the first case he sutured the abdomen, leaving the pack in place, and tied the sutures in double bowknots so that he could reopen the abdomen in forty-eight hours and remove the pack. This resulted in a protracted convalescence. In the other cases he brought the ends of the gauze out through a stab wound in the left loin at the twelfth rib, and in due time removed the pack from the cavity through the stab incision. In one instance he did not realize how large the cavity was after removal of the pack, and a subdiaphragmatic abscess resulted that required operation about six weeks later because of the residuary fluid that was left in the pocket. It is best, therefore, if a pack is left, to remove it on the sixth day or later and insert a catheter to be left in place for a considerable time to be sure that a residual pocket does not form.

Second, the stomach may spread out over the splenic pedicle and may not be identified. In two early cases he accidentally opened the stomach, and in each gastric contents escaped. He was able to suture the gastric opening in both cases. One of these patients died. Obviously one should be sure not to mistake the stomach for part of the pedicle.

Third, in two instances he had removed a large part of the tail of the pancreas. In the first case he did not remember that the tail of the pancreas comes up into the pancreatic notch of the spleen. When the specimen was brought from the laboratory about ten centimetres of the tail of the pancreas was found to have been tied off with the splenic pedicle. Since then he had been very careful to dissect out the tail of the pancreas.

Fourth, in suturing a large adherent area on the under surface of the diaphragm where large veins are bleeding, it is easily possible to tear the diaphragm. This happened with him once. He had the catgut needle in a long Haggard needle holder in order to reach up into the bottom of the cavity. As he put this needle into the diaphragm he should have remembered the force of the contraction of the diaphragm in expiration, but he did not, and held onto the needle with the forceps. The needle tore through the diaphragm and pericardium, and the apex of the heart dropped down into the opening. He was able to suture the rent and the patient got well, but the possibility of this accident is one that must be remembered. When the needle is placed in the diaphragm, have ten inches of catgut free, let go of the needle, and pick it up when inspiration brings it down within reach.

DR ARTHUR D BEVAN (in closing) recalled a quotation from Billroth in which he refers to his great master, Langenbeck, and he makes the statement that the great strength of the Langenbeck school lay in the fact that he

taught his pupils the anatomy and the physiology of the science, and that it was of great importance, the most important thing that he taught, and that that school was continuing still as a great school of surgery

Doctor Bevan thought that surgeons get too far away from anatomy sometimes. He suggested that surgeons who are doing a good deal of this spleen work should get in contact with some friendly pathologist and get the opportunity of testing out the different exposures of the spleen on very fresh post-mortem material. He was quite converted to the position that for all purposes it is wise, in doing a splenectomy, to start with a mid-line incision. One then sees what the conditions are, and if it is absolutely essential, because of the size of the spleen or because of adhesions or hæmorrhage, to obtain a very wide exposure, one can obtain the best exposure by a complete division of the rectus. By this means there may be secured a very much greater exposure than from an incision parallel with the costal arch, or any other incision, because this huge flap can be carried right up over the costal arch, and the incision does not carry any danger of injury to the nerve supply, and lends itself very well to closure without any possibility of hernia.

One can carry on to advantage such anatomical studies not only in this spleen work but in all sorts of operative work. One can acquire in this work on fresh cadavers a mental conception which is really of very great value in the operating room in handling some of these difficult problems.

In many of these spleen lesions, the surgeon should keep in mind the fact that the spleen is simply one part of a very complicated reticulo-endothelial system, and that the mere removal of the spleen does not always clean up the case entirely and remove all of the pathology. This is quite evident in splenic anæmia, where very frequently, in 10 per cent or more of the cases, hæmorrhage recurs in these patients even after the removal of the spleen. That is also true in hemolytic jaundice. He had had one very marked case of hemolytic jaundice where, after the removal of the spleen, the jaundice has persisted, and the picture, as far as fragility is concerned, is exactly the same as it was before.

Another striking illustration of this is the case that Pool referred to, of Gaucher's disease with a deforming arthritis of the hip-joint. Undoubtedly Gaucher's disease involves the entire reticulo-endothelial system. He had a case exactly like Doctor Pool's case, of a woman who has had an enlarged spleen for fifteen years with this same deforming arthritis of the hip-joint, that woman had been operated upon twelve years ago—she was operated on twelve years ago, but the man making the incision thought it was a kidney and made a kidney cut and did not remove the spleen. If that spleen had been removed and she had lived fifteen years, we undoubtedly for a long period would have said that she had been cured of Gaucher's disease by splenectomy. But she now comes back to me with an enormous spleen. She has had two children since this exploratory operation, she is in fair health in spite of this deforming arthritis of the hip. It is a difficult thing, with present knowledge, to make sharp lines of division between these dif-

ferent conditions Undoubtedly many of these splenic conditions fade into each other and we are not as yet able to make very definite classifications

DR ALLEN O WHIPPLE, in connection with the patient that Doctor Pool referred to, spoke of a case of Gaucher's disease in a woman, in a family in which the brother also had had it, and who was operated upon, who at the time of the splenectomy had a peculiar hip condition As a matter of fact, she had been referred from the New York Orthopedic Hospital because of the enlarged spleen

After splenectomy she returned to the New York Orthopedic Hospital for purposes of investigation of the hip-joint, and it was thought at that time that she might have some low-grade pyogenic infection of the joint A simple exploration of the joint, however, revealed no evidence of a suppurative lesion and nothing more was done than to remove a specimen and immobilize the hip-joint for a period of some six to eight weeks The sections showed the same type of cell as had been found in the spleen

That patient has been followed now for a period of four years She has continued to improve and is now able to walk and dance without any discomfort or disability

He further called attention to a point in technic which may possibly arise in some cases of Banti's disease, the vessels in splenomegaly and Banti's disease are sometimes markedly atheromatous and thickened He had a very trying experience in a case on which he was doing a splenectomy In tying the ligature on the artery he found that the ligature cut right through the atheromatous vessel, and there was an immediate hæmorrhage of very severe type Attempts to hold the stump of the vessel and to apply another ligature failed because that also cut through the artery He was faced with the impossibility of applying any clamp or instrument of that sort and it occurred to him that he might use the tail of the pancreas as a buffer The needle with the suture was accordingly carried through pancreatic tissue, with the result that the vessel was tied and controlled Although he watched the patient with great anxiety for fear of having damaged the pancreas and caused a pancreatitis, none developed, and the patient apparently did not suffer from this emergency procedure It may possibly be a useful procedure in an extreme case of that sort

DR ARTHUR E BILLINGS (in closing) referred to the remarks of Doctor Jopson, on the question of exploratory puncture It was his intention to stress its confinement to the cases where the progress of the abscess is toward the thorax as suggested by the existence of pleural and pulmonary symptoms Melchior collected seventeen cases of abscess following typhoid fever in all of which exploratory aspiration was practiced without any untoward effects whatever Morrell, Danbray and Tappe stated that no untoward development had followed the diagnostic puncture One point may be emphasized in this connection and that is that diagnostic puncture should be confined to the cases where there is a thoracic evolution of the abscess, and when one is prepared to go ahead with operation immediately after puncture, if the results so indicate

SURGERY OF THE SYMPATHETIC SYSTEM INDICATIONS AND RESULTS^{*}

BY RENÉ LERICHE, M D

OF STRASBOURG, FRANCE

FROM THE SURGICAL CLINIC OF THE UNIVERSITY OF STRASBOURG

THE surgery of the sympathetic system meets two kinds of difficulties, those which spring from our physiologic ignorance, those which spring from our pathologic ignorance. On one side, we do not know the exact significance of the branches that we cut, on the other side we are ignorant, as a rule, of the cause and the exact mechanism of the diseases which we wish to cure. One understands that in such conditions, surgery acknowledges failures and incomplete results. It is astonishing that it can count so many successes.

Before indicating briefly the results that I have obtained after having made about 400 operations upon the sympathetic system, sixty-four upon the cervical chain, three upon the thoracic sympathetic, sixteen upon the lumbar or sacro-sympathetic, 298 upon the periarterial sympathetic, it is necessary to emphasize three points to which I attach great importance. First, contrary to what has been admitted by most physiologists and which is most in conformance with the old views of François Frank, the sympathetic system appears to us more and more as a vast sensory system everywhere with reflex associations. The researches that we have pursued for the last four years show that it has its own sensitiveness, having its special field not connected with cerebro-spinal sensitiveness. This sensitiveness is in direct relation to the vasomotor reactions which seem controlled by intra parietal peripheral centres. In every case, one fact is absolutely certain—no sympathetic section produces any vasomotor paralysis. Every sympathetic operation (ganglionectomy, ramisection, section of a sympathetic trunk, periarterial sympathectomy) is always followed by an active vasodilatation more or less lasting. This makes itself felt especially distally, but one can find traces of it proximally and often on the opposite side. It is accompanied by increased heat which lasts longer than the oscillometric signs of the vasodilatation. I have found from two to three degrees more temperature on the operated side after ramisections at the end of two years¹. These are facts which tend to show that neurotomies of the sympathetic are sensory neurotomies and not motor, setting free the periphery from a central control. In general, the section of a sympathetic chain or of its branches has effects of the same kind as ablation of its ganglions. These being certainly important centres of conduction, should be respected as much as possible.

¹ Leriche and Fontaine. Experimental and Clinical Contribution to the Question of Innervation of Vessels. Surgery, Gynecology and Obstetrics. Unpublished.

* Read by title

and should not be sacrificed if one can avoid it. The surgery of the sympathetic should attempt to be selective and as conservative as possible.

Every sympathetic neurectomy is followed by the formation of a cicatricial neuroma. In certain patients, this neuroma becomes the point of departure of reflex reactions which reproduce secondarily the primary disease, or syndromes that resemble it. If one infiltrates such a neuroma with novocaine, one may obtain an immediate disappearance of all the existing signs lasting for some hours. If one resects the neuroma, the cure is obtained anew, temporarily at least. A relapse is always possible. One should seek the best method of shunning the formation of voluminous neuromata. Attempts essayed for this purpose have hitherto not given any results.

I submit now the principal results that I have obtained and the conclusions to which they give rise.

A SYMPATHECTOMIES IN VISCERAL DISEASES

1 *Angina Pectoris*²—The ideal operations involve two steps.

a Chief indispensable step: section of the communicating branches which are derived from the controlling ganglion (V, VI, VII, VIII cervical, I dorsal), and

b A complementary intervention upon the superior cervical sympathetic, consisting either of ablation of the superior cervical ganglion, sympathectomy of the upper cervical trunk, section of the upper cardiac nerves or a simple sympathetotomy operation to which one may join, the case having failed, section of the depressor nerve.

The surgical treatment of angina pectoris is based upon sensory and not motor considerations. The operation should be done preferably on the left side but sometimes one must test by novocaine infiltrations at the base of the neck which is the side of choice. I have done this once. I have, with Fontaine, operated upon five anginose patients. Two bad cases (aged patients with incurable heart lesions) have been relieved, not cured, who died six and nine months, respectively, later. One patient has been relieved for eighteen months but has experienced some crises. One case is too recent to be counted. One case remains cured since March, 1925.

2 *Bronchial Asthma*—There exist here the same indications for operation as in angina pectoris, although one would search in a given case whether it may not be better to attack the pneumogastric than the sympathetic. When one has to do with an asthma engrafted upon a chronic bronchitis with marked emphysema, it is necessary to prepare the path for the nerve operations by a removal of costal cartilages for the purpose of mobilizing the thorax which is in a state of rigid, extreme dilatation (operation of Freund) and maintains the emphysema. On five patients operated upon by the ablation of the left star ganglion, two were followed by no result, two were radically cured. One of these cases dates back three years, the other thirty months. They have been recently seen. One late case, benefited by the operation of

² Leriche and Fontaine. Surgical Treatment of Angina Pectoris, What It Is and What It Should Be. American Heart Journal. In Press.

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Freund but the condition aggravated by the removal of the star ganglion, has been cured by right vagotomy. For twelve months he remains without attacks.

3 *Basedow's Disease*—Ablation of the left upper cervical ganglion benefits most of these patients and cures some of them completely, but the thyroid operations have more complete and more constant results. I reserve such an operation as that of Jaboulay to cases of Basedow's disease without goitre. I know of cases cured for several years excepting for a slight exophthalmos. In severe cases, the sympathetic section prepares the ground marvelously for the thyroid operations, but in view of recent progress in medical treatment, especially since the introduction of iodine preparations, the indications for operation no longer assert themselves as in former times.

4 *Gastric Crises of Tabes*—Dorsal ramisection is to be preferred to posterior radicotomy, but it is necessary to remember that these patients always have a recurrence at a more or less distant period.

5 *Gynaecological Affections*—In painful dysmenorrhœa without objective cause, in amenorrhœa without cause, I obtained with hypogastric sympathectomy considerable and lasting amelioration. I have seen re-appear a menstruation which has been absent for a long time. In sclerocystic ovaritis, I obtained from perihypogastric sympathectomy, or section of the pre-sacral nerve of Cotte, disappearance of pain without mutilating operation. In vulvar kraurosis with hypogastric sympathectomy an almost complete cure (disappearance of the leucoplasia, of the retraction and the vaginal dryness) in a case which I followed for three years. In other cases the amelioration was less satisfactory.

6 *Painful Syndromes in Pelvic Cancers*—In inoperable pelvic cancers or after radium therapy, one is often obliged to intervene for the relief of persistent pain. In four cases the sympathectomy of the hypogastric arteries, primary iliacs and the termination of the aorta, have given me at times complete relief of the pain. These operations have demonstrated that in pelvic neoplasms (prostate, uterus) the arteries are involved in a quite marked lymphangitic sclerosis. I prefer this type of operation when it is possible to the cordotomy which too often gives bladder troubles and pyelonephritis.

B SYMPATHECTOMIES IN AFFECTIONS OF THE LIMBS

1 *Painful Syndromata*—In the neuralgias following gunshot wounds, I have had six excellent results giving return to normal state and to active life, two cases of amelioration with diminution of pain without real cure and two complete failures, that is to say, four failures in ten cases. In cases of diffuse post-traumatic pain (old ascending neuritis), periarterial sympathectomy has always failed. On the contrary, I have had very great improvement, one might say lasting cures, from ramisection (three cases). In painful stumps, it is necessary to distinguish pain localized in a nerve trunk which may be cured by resection of the neuroma, from diffuse pains in the stump associated with vasomotor trouble and ulcerations, which are healed by periarterial sympathectomy and from major pains in the stump.

with marked mental disturbances which give way only to posterior radicotomy and to ramisection. In the cases of pain with cyanosis, complicated with œdema, and trophic disturbances, I have had four cures in six cases, two of which have been followed up for two and three years respectively. In the class of major pains, posterior radicotomy has given me two good results and two failures. Ramisection in four cases has given me a cure lasting for three years, two cases of marked improvement and one relapse after operation upon the stump. This case has later been re-operated by posterior radicotomy and remained cured now for five months.

2 Vasomotor Disease—The name "Raynaud's Disease" should be reserved for diseases purely vasomotor in their nature according to the typical description of Raynaud, exhibiting complete integrity of the circulation in the interval of crises. I agree with Allen and Brown (*American Journal of Medical Sciences*, vol. clxxiv, September, 1927, pp. 31 and 329), in admitting that many arterial diseases, especially arteritis, simulate at the beginning Raynaud's Disease. This diagnostic error should be avoided. In true Raynaud's Disease, simple periarterial sympathectomy done on both sides produces a permanent cure. I have recently seen a young girl upon whom I operated April 5, 1924, for a condition marked by typical crises and normal circulation in the intervals. I did a perihumeral and a perfemoral sympathectomy. The patient has remained well for four years.

A butcher subjected to unilateral sympathectomy in February, 1924, has remained cured on the side operated for two years but has had crises on the other side.

A woman, sixty-eight years of age, operated upon November 13, 1924, was well in April, 1926.

In certain cases I have combined ramisection with the periarterial sympathectomy. I have obtained thus, with Fontaine, very good results in a bad case. In this patient the disappearance of the painful crises has been maintained for two years and two months. But one will always miscarry if one makes an error in diagnosis and mistakes as Raynaud's Disease arteritis or a thromboangitis of Buerger.

In Acrocyanosis—I have obtained a good result in the only case upon which I have operated. This patient has just been married, eighteen months after operation and is in an excellent state of health.

In Erythromelalgia—Sympathetic operations fail.

In Scleroderma—The sympathectomies give very noticeable results. In isolated sclerodactylitis, periarterial sympathectomy alone may be sufficient, but the combined operations are demanded in severe cases where the manifestations are multiple, even if not generalized, and in which there are large parchment-like areas manifestly incurable. Personally I have operated upon three cases of scleroderma and in one case of chronic atrophic dermatitis (Disease of Herxheimer-Pick). In the first case, I did, in December, 1924, a double perihumeral sympathectomy, followed after a brief interval by abla-

tion of the superior cervical ganglion on the right side and an inferior cervical ramisection on the left. The improvement was at once very considerable and at the end of three years the progress of the sclerodermic condition seemed arrested in the face, which no longer presented a fixed and immovable mass. At present, the mobility of the fingers is perfect and the sensibility of the ungual tips very good. The result is certainly much better than could have been hoped for. So also in two other cases as well as in the case of Herxheimer-Pick's disease. In Germany, Bruening and Stahl, Horn and many others have noted equal successes.

3 *Organic Diseases of the Arteries*—By the vasodilatation which it produces in a constant manner, sympathectomy is susceptible of useful employment in arterial lesions accompanied by a diminution of the peripheral blood supply or which are aggravated by spasm, producing a condition in which the peripheral capillary net-work is dilatable and the blood supply is restored. We shall consider in succession sympathectomy in (a) traumatic lesions of large arteries, (b) arteritis of the aged, (c) arteritis of the young.

Traumatic Arterial Lesions—In traumatic lesions of the arteries, one may make use of periarterial sympathectomy either to favor the establishment of collateral circulation or to avoid the troubles engendered by a ligature or by post traumatic thrombosis. In order to favor the establishment of collateral circulation after sudden ligature of a large vessel, the best way to act is to substitute for the simple ligature resection between two points as proposed by the author at the 31st French Congress of Surgery (Strasbourg, 1921). In this way, one accomplishes a sympathectomy by which the troubles of the ligatures are avoided. With the same idea Scalone has suggested sympathectomy to be done upon the segment proximal to the ligature, which gave him excellent results in two cases. Quite lately, I have resected in this manner the whole of the obliterated segment, about 10 cm. in length, from the external iliac artery of a man who, half an hour before, had sustained a severe contusion of the inguinal region. This man recovered without incident and presents in walking not the least vascular trouble. The troubles occasioned by a ligature or a post traumatic thrombosis do not all depend upon the ischæmia. Certain of them depend, no doubt, upon the lasting irritation of the periarterial sympathetic at the level of the obliterated vascular segment. The resection of this segment causes a cessation of the spasms which had resulted. I think it necessary each time that an artery is obliterated and that vascular suture is not possible, that an arteriectomy should be done extending into healthy tissue in order to escape the vascular troubles which may develop from the obliterated fragment. Since 1917, I have followed this practice and never had to regret it.

Arteritis of the Aged—In the arteritis of the aged, operations upon the sympathetic can have only a palliative value. As far as symptomatic operations go they may be directed (a) against pain, (b) against intermittent claudication, (c) against ischæmic gangrene.

a *Against Pain*—Among the aged who suffer from arteritis, those whose pain is premonitory of gangrene and is accompanied by vasomotor crises with coldness and phases of cyanosis of the extremities are most usually relieved by periarterial sympathectomy, of eight cases so operated upon by me, three resulted in complete failures, two in moderate amelioration and three in complete disappearance of the pain, two of which later enjoyed a long period of immunity Bruning, Kappis, Uffreduzzi, Pieri and Chastenet de Gery have had equally satisfactory results When, on the contrary, the pain assumes a pure neuralgic character, I think that a periarterial sympathectomy must be abandoned in favor of multiple neurotomies after the method of Quénu Sympathectomy is equally contraindicated when there exists manifest signs of peripheral vasodilatation

b *Intermittent Claudication*—This in itself appears to me to be a bad indication for sympathectomy

c *In Beginning Ischæmic Gangrene*—Sympathectomy has often been tried in the hope of thus limiting the necrotic process so as to permit limited amputations (Chastenet de Géry) Jianu and Handley have reported excellent results from this procedure and Calandra and Uffreduzzi have shown that successes may be lasting Failures are, however, not rare My personal experience comprises but eight cases I have noted in five cases no results, but in three cases the sympathectomy permitted me to limit the amputation to the sacrifice of the gangrenous parts alone These patients healed perfectly It seems then that sympathectomy may be useful in certain cases and that it is not so in others But one never loses anything by trying On the contrary, it often permits one to appeal from the classic formula which advises to do always a high amputation in arterial gangrene For example, one would amputate through the thigh for a limited gangrene of the foot

Chronic Arteritis in the Young—Although it may be indisputable that periarterial irritation of the sympathetic explains a good part of the troubles which patients suffer who are attacked with juvenile arteritis, it seems to me not less sure that from a *priori* reasons the extent and dispersion of these lesions would render of no avail all therapeutic attempts through sympathectomy I have also always been opposed to the employment of a periarterial sympathectomy in cases of chronic juvenile arteritis and I have never considered that it had a place either in intermittent claudication or in the painful vasomotor manifestations which accompanied the affection So, notwithstanding very appreciable results have been reported from divers surgeons, I see for sympathectomy in the treatment of juvenile arteritis but one indication namely, the existence of pain of a vasomotor type Up to this time, I have operated upon twelve patients, eight of whom suffered from Buerger's type of disease, but even in these cases the effect of the sympathectomies is very transient There are only two lasting successes All the other patients relapsed rapidly within a space of a few days to some months Influenced by the researches of Oppel, I am using now in chronic juvenile arteritis,

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left adrenalectomy which has given me results much more satisfactory than operations upon the sympathetic

4 *Disease of Venous System*—For the consequences of phlebitis, sympathectomy seems to me to be very frequently indicated, either to be used alone or in addition to the liberation of a vein involved in sclerotic tissue, or the resection of an obliterated venous trunk. I have obtained very favorable results in phlebitic ulcers, in varicose eczema, in the pain and cramps consecutive to old phlebitis

5 *Edemas*—It is quite natural also that one should think of employing the sympathetic operations in the surgical œdemas which supervene in every renal or cardiac affection. Are not these œdemas the evident manifestation of a vasomotor trouble? They comprise the acute traumatic œdema, the œdemas of the lower limbs in consequence of periphlebitis of the pelvic veins, œdemas dependent upon hidden spina bifida

Acute Traumatic Edemas have been observed frequently during the late war as well as in the civil practice of accidents. In these I have seen cases of very surprising benefit resulting from sympathectomy. Thus in a railway employee who, five hours after having received the weight of a wagon upon the back of the hand, had developed an enormous œdema with stiffness and paresis of the fingers. In this case the œdema which had persisted notwithstanding the most varied methods of treatment during more than two months, was completely healed four hours after perihumeral sympathectomy and remained so for five years. Analogous results have been recorded by Bianchetti, Wertheimer and myself in two other cases. In œdemas of the lower extremities of spontaneous origin, I think that very frequently a phlebitis of the pelvic veins is the cause and I have in several of these cases uncovered these vessels, resected the obliterated veins and obtained a very appreciable diminution of the œdema. When one has to do with an occult spina bifida, intervention must be made upon the spine and not upon the sympathetic

6 *Chronic Ulcerations With the Exception of Those of Nervous Origin*—Chronic ulcers, other than those of nervous origin, occur especially in the lower limb. It is in fact the chapter on ulcers of the leg that I open here. Of these, the most frequent are (a) varicose ulcers, (b) ulcers developing upon old burn cicatrices, (c) ulcers dependent upon phlebitis of the veins of the pelvis, (d) ulcers developing upon an old complicated fracture-callus, (e) ulcers in amputation stumps. These different causes all end finally in the production of a chronic ulceration which has little tendency to heal and recurs with great facility each time that healing has with difficulty been obtained. The cause of the ulcer varies according to its type. There has to be settled the category and the therapeutic indication according to the group with which one has to do, but when the etiological treatment is inaugurated, there remains a problem of ulceration proper of which one does not always take sufficient account. In fact, the treatment of chronic ulcers should always resolve itself into a double problem that of the cause and that of the

ulcer itself. Since the problem of the ulcer proper is common to all the groups, it is to this that I will first address myself.

Chronic ulcers of the leg are distinguished by their incurability and their great tendency to recur. Why is this so? Why is it so difficult to make heal

chronic ulcers of the leg?

It has seemed to us, Fontaine and myself, that three causes especially occasion the incurability of these ulcers. There is first the fact that the ulcer is consecutive to a dermo-epidermic necrosis springing from an arterial ischaemia, sometimes spasmodic, which creates a positive loss of substance always much greater than the apparent ulceration. The ulcer is incurable because the bad local circulatory conditions lead to an imperfect nutrition of the soft parts where the viability of the tissues is always mediocre. Finally, the deep infection by all kinds of micro-organisms in the surface of the ulcer must be taken into account, an infection which does not disappear even after weeks of rest and varied methods of treatment. Indeed, an ulcer, whether varicose,



FIGS 1 and 2 show varicose ulcers for which perifemoral sympathectomy was performed. Ten days later skin grafts were applied. Figure 2 shows the ulcers completely healed. The result still persists two and one half years after the operation.

phlebotic, postphlebotic or due to excessive callus, fails to heal or always recurs because it is seated in the worst conditions of life and repair. This fact, based upon the anatomico-pathological examinations of numerous excised ulcers, has led Fontaine and myself to say that every good method of treatment of chronic ulcers of the leg should involve removal of the causes favoring local recurrence by changing the circulation and the conditions of the skin, by sterilizing the ulcer and by the removal of the cicatricial skin and its replacement by skin of good quality. Now numerous experimental and clinical researches, which the reader will find set forth in the number of the

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ANNALS OF SURGERY for November, 1926, have demonstrated that sympathectomy is capable of transforming the terrain upon which an ulcer develops at the same time as it favors its sterilization. An ulcer of the leg is infected by various microbes, among which predominate the staphylo-, strepto-, and micrococcus

candicans. The bottom of the wound is grayish and covered with sanies. There is a fibrinous layer within which are enclosed the microbes. Sympathectomy quickly exaggerates the suppuration but by the third or fourth day it has diminished and it is remarkable, after rubbing, to see polymorphonuclear cells re-appear and devour the microbes. At the end of three or four days there are no more free microbes and the fibrinous net-work has disappeared, it is replaced by normal granulation tissue. By the fifth to the eighth day at the soil of the wound, there are only numerous polymorphonuclears in good condition and large normal mononuclears resting upon a normal tissue. Microscopically, the red wound covered with granulations of good quality has lost its aspect of a pathological ulceration tendency and



FIG. 2.—Ulcers completely healed. See FIG. 1

epidermization appears and the sterile wound is in course of regular repair. In fact, under the conditions of active vasodilatation and phagocytosis, the conditions have been changed from that of a chronic ulcer whilst the afflux of the large mononuclears continues the repair. Thus may be found explained the striking effect of periaxial sympathectomy in chronic ulcers: the rapidity of the changes which it produces in a torpid wound and the quickness of the healing which follows.

This rapidity has been measured with exactness. Jeanneney and Mathey-Cornat have studied it with relation to its oscillometric and thermometric qualities. They have seen that the curve is parallel to the curves of pressure as indicated by the oscillometric index and that of local temperature. Mouchet and Guillemin, also, have shown that the daily coefficient of cicatrization after a sympathectomy was much superior to that following other methods of hyperæmia such as the section of the internal saphenous nerve of Proust and of Nabias. One can say, therefore, that this rapidity of cicatrization seems due to multiple factors, including vasodilatation, sterilization of infected surfaces, modification of the wound field, increased vitality of the tissues. These last words should not be considered as a simple verbal-



FIGS 3-8—Quadruple varicose ulcers. Figure 3 shows the right external malleolar region. Figure 4 shows the right internal malleolar region. Figure 5 shows the left external malleolar region. Figure 6 shows the left internal malleolar region. Peri-femoral sympathectomy was performed on September 3, 1926, and ten days after skin grafts were applied. Figures 7 and 8, results obtained twenty days after the grafts. In April 1928, patient remains cured.

ism. The vitality is exalted every time that the circulatory conditions are improved. But if it is certain that periarterial sympathectomy has a very powerful effect upon ulceration, it is not less true that by itself it is not sufficient to maintain the cure. It does not protect from recurrences. For the spontaneous cicatrization which it brings about can produce only a cicatricial tissue of bad quality with epidermis so thin, so glossy and so fragile that a recurrence may follow the least bruise. To prevent this, it is absolutely necessary to substitute for the poor skin a skin of good quality. In other words, it is necessary to combine cutaneous grafts with periarterial sympathectomy. By this combined method of treatment of ulcers of the leg, I expect from the sympathectomy only such transformation of the nutritive and circulatory conditions of the ulcer as will make out of the chronic atonic ulcer a granulating wound, while it is from the cutaneous grafts I expect final success. So the treatment of ulceration proper consists in periarterial sympathectomy and, at the most favorable moment, that is to say, between the seventh and twelfth days, in the implantation of cutaneous grafts for which I use, in general, the grafts of Halsted-Davis. This treatment does not take the place in any respect of therapeutis called

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for by the cause of the ulcer, as I will show in passing in review the different classes of ulcers of the leg

Varicose Ulcers—Many authors class as varicose ulcers every ulcer of the leg which is not frankly syphilitic. Contrary to this conception, I accept as a varicose ulcer only one which is developed upon a base plainly varicose, at the centre of which is a varix. The etiological treatment will be, in such cases, that of varices. I make it a habit at the time of the sympathectomy to add to it a saphenectomy after the manner of Babcock.

Syphilitic Ulcers—Among ulcers of the leg I think that many are syphilitic, whether a positive Wassermann is absent or the syphilis is unquestionable. In these cases every time then, where there are no plain varices, I always begin by a treatment test whatever may be the laboratory response. I have often seen the ulcer become clean and contract very rapidly. To hasten the cure, I apply Davis grafts as soon as the ulcer is in proper condition.

Aside from true varicose ulcers and from syphilitic ulcers, there remain a certain number whose origin may not be clear. In such cases I content myself with the treatment just described, which is equally applicable to ulcers resulting from old burns. *Ulcerations dependent upon phlebitis of the pelvic veins* are much more frequent than has been thought. I think that in such cases the treatment of the ulcer is less important than the



FIG. 4.—Varicose ulcer right internal malleolar region.

direct intervention upon the veins of the pelvis. By laparotomy one must verify their presence and resect the obliterated segments. If such intervention does not suffice to bring about cure, one may add then, and then only, that of the ulcer itself. In two cases where I limited the operation to the ulcer without previous laparotomy, I saw rapid recurrence.

Ulcers based upon the callus of an old complicated fracture display the important part which an etiological treatment should take. The skin becomes ulcerated over exuberant callus because over this excessive callus the integument is stretched as upon a rack and its circulation interfered with. To treat such an ulcer without first remedying its origin is to expose it to failure or rapid recurrence. This I have seen twice. In two cases final cure was obtained only when the volume of the callus had been lessened.

In stump ulcers, sympathectomy followed by grafting is certainly the method of choice.

Up to the present time, I have treated twenty-four cases of ulcers of the leg by the combined method, adding to it each time whatever was indicated by the requirements of appropriate etiologic treatment. Among these twenty-four cases, there were fifteen cases of varicose ulcers, all very old, in seven of whom the varices were very marked. Saphenectomy was done as a part of the combined method in these cases. In all the others, I have commenced by precautionary antisyphilitic treatment and I have resorted to sympathectomy only after failure of the antispasmodic cure. I have applied the same treatment to three cases of ulcers following old burns, to two cases of stump ulcers and to one of chronic ulcer supervening upon an operative cicatrix. In all these cases, the method of a periarterial sympathectomy combined with cutaneous grafts has enabled me to obtain a supple and mobile skin covering the deeper layers. I have no operative failure. Re-seen after a long interval, my patients present skin grafts of good quality possessing all the properties



FIG. 5.—Varicose ulcer, left internal malleolar region

of normal integument which, at the end of some months, is distinguishable from the neighboring skin only by the persistence of a raised surface, although its vascularization and sensibility are normal. Being of good quality, the grafted skin is able to resist external shocks and thus avoid recurrences. Quite lately I have seen again all those operated upon by me, the eldest of

whom dates back to two years or more while the more recent dates back only a few months. I have thus been able to convince myself that the cure obtained is permanent.

In none of these operated patients has recurrence taken place in the grafted zones, although in some recurrence has taken place in the zones of pigmentary dermatitis bordering upon the old ulcer. So in the hope of escaping these recurrences, I have adopted the habit of preceding the grafting of the ulcer by its excision, removing at the same time the entire pigmented zone which surrounds it.

Two conditions may be present, the ulcer and the pigmented zone may be of slight dimensions so that the complete excision into healthy skin may be done. In such cases, the operation brings about a definite cure. Or, the lesions may have an extent too great for an excision to include their whole extent. I excise then as much as I can. It is in these cases that I have observed recurrences.

En résumé, an experience of several years during which I have actively

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occupied myself with the treatment of ulcers of the leg has shown me that every ulcer of the leg requires double treatment, that of the ulceration itself and that of the cause of the ulcer. In certain cases, such as ulcers following burns, chronic non-varicose ulcers of the leg, the etiology is nothing, the ulcer is all, the treatment of the ulcer is the first thing. There are other cases such as ulcers caused by exuberant callus and ulcers caused by pelvic phlebitis in which, on the contrary, the etiological treatment takes precedence. There are varicose ulcers finally in which the two ideas are easily and usefully combined. The results of the combined methods of sympathectomy and cutaneous grafts in the treatment of ulcers are very satisfactory in their ultimate state. The skin obtained is supple and of good quality. It prevents recurrences. Certain cure can be obtained only if one combines excision of the ulcer and of the neighboring parts with sympathectomy and cutaneous grafts. When such excision is technically impossible, recurrences in the non-grafted parts are to be feared but by proceeding step by step and by treating these recurrences in the same way, one can finally obtain complete cicatrization.



FIG. 6—Varicose ulcer, left internal malleolar region

7 *Ulcerations of Nervous Origin*—In the

ulcers symptomatic of tabes, syringo-myelia, myelitis or spina bifida, I think that sympathectomy is contraindicated notwithstanding the results published by Mathey-Cornat. I have never resorted to it in these conditions. Likewise, I do not think that the perforating plantar ulcer should be retained as an indication for sympathetic interference. On the other hand, in trophic ulcerations following spinal cord injuries, Bardon and Mathey-Cornat, Brunning and I, myself, have obtained very evident benefit. In the chronic ulcers consecutive to wounds of great nerve trunks, periarterial sympathectomy has often been employed. I think that in these cases the trophic troubles are produced only when there is a neuroma of the proximal end of the cut nerve. The true prophylaxis and the best treatment of these cases of ulceration consist in the repair as soon as possible of the nerve by direct suture or by grafts after having replaced the foot in good position by such orthopedic intervention as may be called for. If, nevertheless, ulcers follow or fail to heal sympathectomy may be resorted to. Like Stahl, and like Villardel, I have observed in such cases rapid cures, lasting for four years and more. So also, in ulcerated stumps where certainly sympathectomies have given brilliant

successes, I combine sympathectomy with excision of the ulcer followed by the application of cutaneous grafts

8 *The Ischæmic Contracture of Volkmann*—Volkmann's syndrome is very frequently the result of an arterial traumatic contusion which has been followed by thrombosis, sometimes even with rupture and hemorrhage. The ischæmic necrosis is dependent directly upon such injury and the consecutive sympathetic troubles accentuate still more the vasomotor phenomena. In such cases there takes place, moreover, very rapid advance which can be explained only by irritation of the periarterial sympathetic plexuses. In cases of arterial thrombosis, the treatment of choice will be the resection of the obliterated segment. I have done this twice, once in a little girl six years

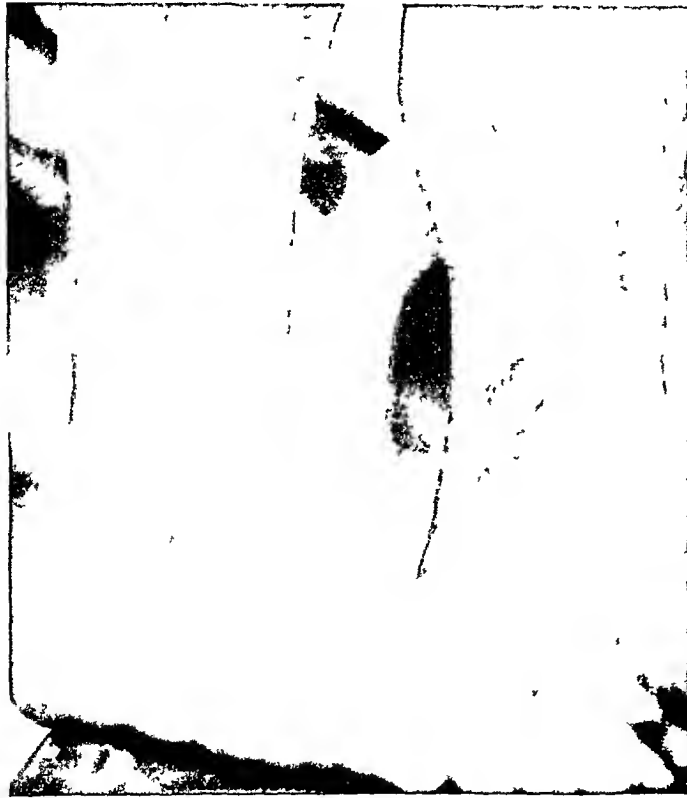


FIG. 7.—Results obtained in varicose ulcers after perifemoral sympathectomy followed by skin grafting. Photo taken twenty days after the grafting.

of age and once in a boy of ten years, both of whom had a fracture of the elbow which had been treated in strong flexion with a plaster apparatus, the syndrome of Volkmann appeared soon after the immobilization. In both these cases there was found complete arterial obliteration and in both, resection of these segments restored to the muscles of the forearm complete mobility (Figs 9, 10 and 11). In the same way, I have operated upon acute cases of Volkmann's syndrome supervening upon muscular wounds of the forearm. In these cases the perihumeral sympathectomy was followed

by a rapid cessation of the arterial spasm, restoring the integrity of motion.

9 *Diseases of Bones and Joints*—It seems to me that in the diseases of bones and joints, sympathectomy may find multiple indications. One may consider sympathetic operations in delayed consolidation, in osteo-articular tuberculoses, in osteoporosis and in traumatic arthritis.

a *Delayed Consolidation*—From the researches which I have undertaken with Professor Policard, it has been established that vasomotor phenomena play a very important rôle in ossification and in consolidation of fractures. If, for one reason or another, the hyperemia which presides over ossification, and which regulates modifications of connective tissue and local

changes in calcification, should be interfered with before the end of the processes of repair, delay of consolidation follows. It was, therefore, logical to try to influence such delays in consolidation by a periarterial sympathectomy.

Experimentally, Uffreduzzi and his pupils Mariano and Palma, have proved that the rapidity of ossification is accelerated after sympathectomy. In my own laboratory, Fontaine came to the same conclusions by making upon rabbits and dogs identical fractures on both sides. In such cases we have always observed, Fontaine and myself, that consolidation was much more rapid on the sympathectomized side. The more recent experiments of Professor Gaudier speak in the same way. In man, Cotte, Uffreduzzi, Kappis, Roubachoff and Stropeni as well as Gaudier and Estor, have established the good effects of sympathectomy in the consolidation of recent fractures and in cases of delayed consolidation. It is evident that sympathectomy does not

act when one has to do with a true pseudarthrosis due to fibrous or muscular interposition. Personally, I have twice resorted to sympathectomy in recent fractures and eleven times in cases of delayed consolidation and secondary resorption of callus or pseudarthrosis after failure of bony union. In four cases, I obtained no result, in one case, the patient was lost sight of, in six other cases the fractures healed very rapidly after the sympathectomy. This, then, appears to me always indicated in delayed



FIG 8—Same as Fig 7

consolidation when one is sure that there is no true pseudarthrosis present.

b *In Osteo-articular Tuberculoses* sympathectomy has been tried by Floresco and later by Gundermann, Laewen, Sebestyen, etc. Callandra and Beirtoni have operated in such cases and in Russia a certain number of observations have been published. Six cases of osteo-articular tuberculosis, in which I performed sympathectomy, were reported by Fontaine in 1925, and since then I have operated upon five others. The balance sheet in osteo-articular tuberculosis is unsatisfactory, although there exist indisputable cases in which such intervention has had a very notable result. It seems to me, according to my own personal experience and in accordance with what I have gathered from reading published cases, that the better results have been obtained in cases attended with fistulæ and with elimination of numerous

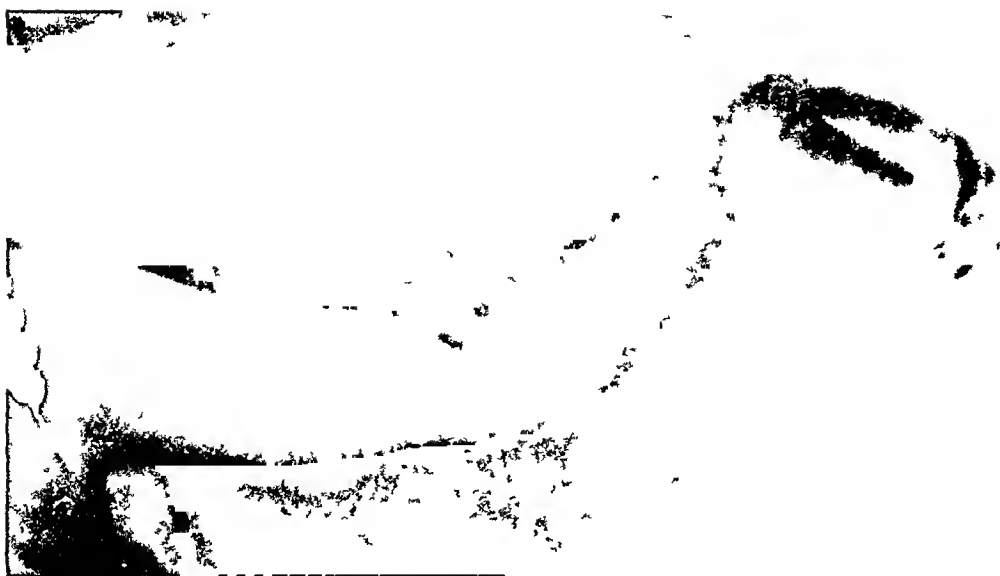


FIG 9—Ischemic Contracture of Volkmann Position of the left upper extremity day before the operation

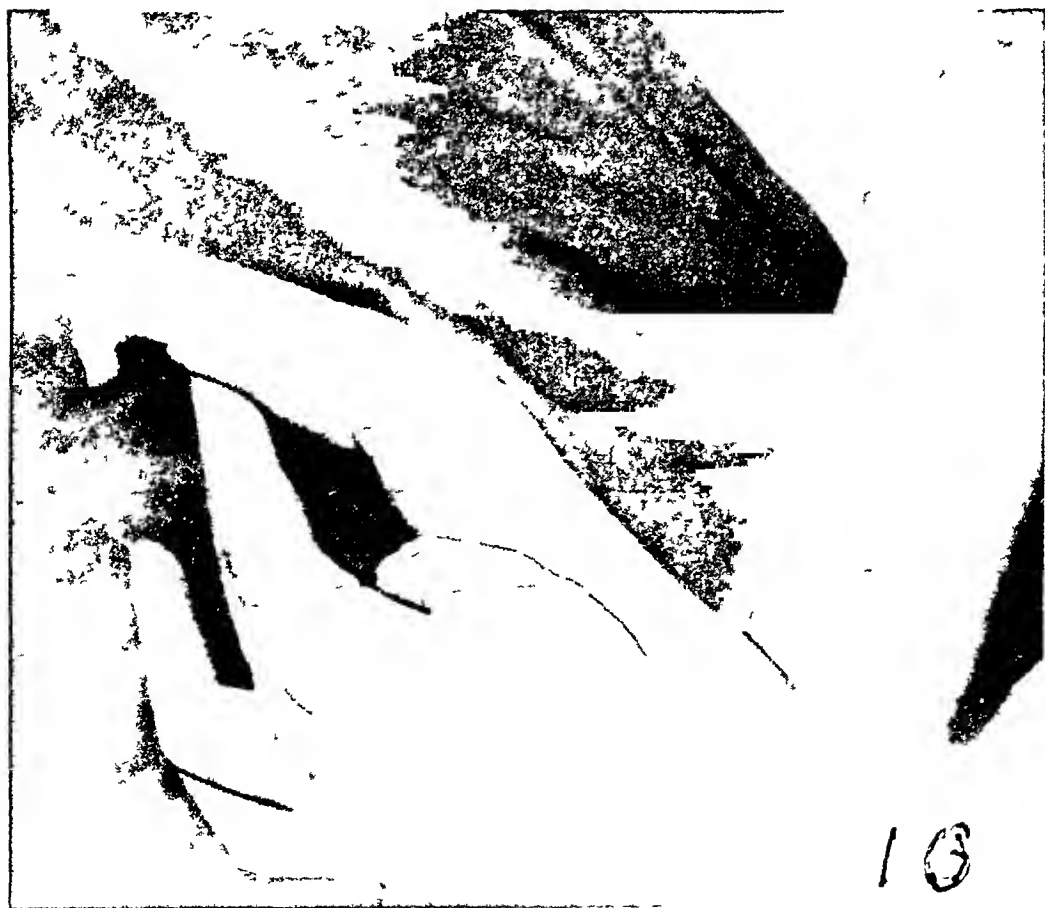


FIG 10—Extension of the wrist In this position complete extension of the fingers is impossible

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FIG 11—Result obtained nine months after the operation. The extension of the fingers is normal, the exception of the second interphalangeal joint of the index finger.



FIG 12

FIG 12—Osteoporosis of bones of left foot after severe trauma. Patient has been in bed on left lumbar laminectomy was performed on November 26, 1926. The pain disappeared instantly. Sixteen days later the patient began to walk. Three and one-half months after the operation the bones of the left foot were completely reabsorbed (See Fig 13).

sequestra, which is often followed by rapid ankylosis. I have also observed some surprising results in white swellings of the wrist. In these later cases the reservation should be made that many cases of so-called tuberculosis of the wrist are really only cases of traumatic osteoporosis.

c *Osteoporosis and Traumatic Arthritis*—The osteoporoses of traumatic origin are much more frequent than one would think. They ought to be better known. When in 1924 I came to Strasbourg, I was shown a patient



FIG 13—Osteoporosis. Three and one half months after lumbar ramisection (See Fig 12)

twenty years of age who had been already under treatment for several months in the clinic for an extremely painful swelling with complete loss of function of the right wrist. These symptoms had supervened some weeks after an accident in his work, producing strong hyperflexion of the wrist. The X-ray showed rarefaction of the carpal bones and it seemed that there existed a focus of bacillus infection in the middle of the os magnum. Notwithstanding this patient had been immobilized in plaster already for several months, he continued to suffer.

In December, 1924, I made a perihumeral sympathectomy without tak-

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ing the hand out of the plaster. In a very few days the œdema had disappeared, the wrist became painless and two months later all trace of swelling had disappeared and the patient had regained all movements of his wrist. The X-ray view of the bonelets showed them re-calcified. In retrospect I was able to make the diagnosis of traumatic osteoporosis. These cases are less rare than has been thought. I have observed several of them. All have been presented to me as cases of tuberculosis of the wrist or of the tarsus.



FIG. 14.—Osteoporosis of bones of foot after a slight trauma of the foot several months previous. The X-ray showed a very marked degree of decalcification of all the bones of the foot. Perifemoral sympathectomy was performed on November 26, 1926. The pain disappeared immediately and two months later a new X-ray (Fig. 15) showed a nearly complete recalcification of the bones.

Sympathectomy is very efficient against osteoporosis: the pain ceases in a very few days, the swelling disappears and the patient regains full motion. I consider, even at the present time, traumatic osteoporosis as one of the most favorable indications for sympathectomy. Osteoporosis may occur in any of the bones. It affects especially the tarsus and the carpus. Anatomically, it produces an hyperæmic rarefaction of the bone which becomes porous. In an epiphysis this rarefaction may bring about detachment of the diarthrodial cartilage with a resulting traumatic arthritis. Traumatic arthritis and osteoporosis are then phenomena of similar nature, to be distinguished only by their seat, whether epiphyseal or diaphyseal. They are the consequence of the reflexes of the torn axons attending traumatism which involve the articular and periarticular regions. The disturbance of these regions, ever rich in nerves, suffices to provoke instantly a very important modification of the local circulation of the limbs as has been shown by my pupils, Fontaine and Miloyevitch. The complex character of the articulation of the tarsus and of the

carpus explains the frequency of such poroses of the wrist and of the foot. They yield always to operations upon the sympathetic.

Traumatic arthritis is observed most frequently in the shoulder and the knee. For the lesions of the shoulder, I practice perisubclavicular sym-



FIG 15 —Condition of bones in case of osteoporosis two months after perifemoral sympathectomy in person of patient shown in Fig 14

pathectomy. For the traumatic arthritis of the knee, I betake myself, according to the case, to perifemoral sympathectomy. To perisubclavicular sympathectomy, I owe, in the treatment of traumatic arthritis, two successes with almost complete functional recovery of all the movements of the shoulder.³

* * * *

From the exposé which I have just made, it results that operations upon the sympathetic already possess very many indications, but I can never emphasize too strongly that in order to give successes such intervention should not be employed carelessly. They do not constitute methods of random treatment.

³ Leriche. Mécanisme des hyarthroses et des arthrites traumatiques. *Soc de Chirurgie de Lyon*, 8 décembre, 1927, in *Lyon Chirurgical*, Tome XXV, No 2, 1928, p 225

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as certain surgeons would have wished to do with them, but, based upon precise physiology as we begin to see, they have indications not less precise I have reported those which have appeared to me at the actual moment the clearest

One word in conclusion When is it necessary to employ periarterial sympathectomy? When is it necessary to practice the intervention upon the sympathetic chain itself and when is it better to attack communicating branches?

The physiological researches which I have undertaken with Fontaine and which will appear *en résumé* in a near number of *Surgery, Gynæcology and Obstetrics*, will have arrived at the following conclusions

Intervention upon the chain itself, the division of communicating branches, and periarterial sympathectomy have all three the same influence upon circulation There exist between the circulatory modification of periarterial sympathectomy and those which one sees after intervention upon the chain or sections of the communicating branches, only quantitative differences, not qualitative They are less marked in the first case than in the second

Interventions upon the sympathetic chain have many inconveniences in as much as they often expose to serious post-operative trouble

Preferably, therefore, it is to intervention upon the periarterial sympathetic or the sections of the communicating branches that one should resort Of these two kinds of intervention, one should choose ramisection every time when one wishes to obtain a strong effect or when one has to do with lesions of long duration In all other cases, it is periarterial sympathectomy that one should always try in the first place for, besides its therapeutic efficiency, it adds simplicity of execution

CLINICAL STUDIES OF ADRENALECTOMY AND SYMPATHECTOMY

BY GEORGE W. CRILE, M.D.

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FOURTEEN years ago in an attempt to apply principles which were first enunciated in an Ether Day address in the Massachusetts General Hospital in 1910, I began a series of operations in which adrenalectomy was either performed alone or was combined with sympathectomy or with thyroidectomy or with both, in an attempt to control certain diseases by lessening what at that time I first termed the "kinetic drive." The aim was to devise a general plan of reducing certain activities with no pretense of the actual cause—a broadened conception of the operation for hyperthyroidism. Twenty-nine such operations have now been performed—sympathectomy alone in two cases, adrenalectomy alone in twelve cases, adrenalectomy and thyroidectomy in five cases, adrenalectomy, thyroidectomy and sympathectomy in eight cases, adrenalectomy, ligation and sympathectomy in two cases.

These operations have been performed for the following conditions: (1) Epilepsy, (2) neurasthenia, (3) hypertension, (4) endarteritis obliterans, and (5) hyperthyroidism and hypertension.

Epilepsy—Thirteen operations have been performed for epilepsy—sympathectomy in one case, adrenalectomy in four cases, adrenalectomy, ligation and sympathectomy in two cases, adrenalectomy and thyroidectomy in one case, adrenalectomy, thyroidectomy and sympathectomy in five cases. All but one, the first in this series to be performed, were undertaken in the belief that the enormous discharge of energy manifested in epileptic convulsions might be dependent either upon the adrenal output alone or upon the interaction of the adrenals and the thyroid gland. It is not necessary at this time to review the effect upon the organism as a whole, of the total removal of the adrenals or of the thyroid. It is well known that in either case the brain becomes incapable of normal action and that the animal becomes adynamic.

A study of the end results in this group of cases shows that adrenalectomy by itself is practically without effect, the combination of adrenalectomy, thyroidectomy and sympathectomy, however, has modified the course of the disease in certain cases. One patient reported five and a half years after operation that the attacks occurred only "two-thirds as often and were one-third as severe" as before operation. Another reported four years after operation that his attacks which before operation had occurred several times in a day, occurred only at intervals of two months or more, he had no digestive trouble, felt very much improved, had gained weight, and was able to work every day. This patient reported again, eight years after his

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operation, that he still felt much better than before operation although the attacks were occurring twice a week, but they lasted for two or three minutes only and occurred at night, so that he was able to continue at work. In another case, before operation the attacks came almost daily, two years after the operation the average interval between the attacks was six months. Seven years afterward this patient had attacks only in March, August, and September. In one other case the patient, who has lived for thirteen years since operation, has had no attacks for eleven years. Four, therefore, out of the five cases of epilepsy in which adrenalectomy, thyroidectomy and sympathectomy were performed have shown definite improvement, and one of these patients is completely cured.

Neurasthenia—In 1917, four operations were performed in cases of neurasthenia. The operation which we might term “dekineticization” was performed in the belief that since the brain is sensitized by the adrenals and the thyroid it can be desensitized by reducing the activity of these two organs. In one of these cases the patient was not improved. In another the patient reported one year after operation that he was unimproved, but later it was learned that for fourteen months he had been employed in an ammunition train of the A E F. Since before operation he had been unable to exert himself for even a half day without becoming completely exhausted, and for six months had made no attempt to do hard labor, we may conclude that whatever his subjective feelings, his physical condition was improved. Whether or not that was due to the psychic effect of the war or to the operation must remain *sub judice*. In another case of neurasthenia the patient had been on prolonged medical treatment, was very weak, had tachycardia, insomnia, and gastro-intestinal disturbances which were manifested by nausea, vomiting, attacks of dizziness, and severe epigastric pains. The patient left the hospital in an improved condition and a grateful letter received eight months later, although it does not specifically refer to the patient's condition, would never have been written in the presence of the old symptoms. It has not been possible to trace this patient for a further report. In another case the immediate result as entered upon the operative report was that the patient was “well”. Six months later a report from the patient's physician read as follows: “There is no sweating of the hands or feet and he has lost his tremor, his heart action is practically normal, and his pulse is 80 after he ascends a flight of stairs. He is dressing tools for drilling oil wells, which is very heavy work. He is making a very remarkable recovery.” In this case adrenalectomy, thyroidectomy and sympathectomy were performed.

We feel that in this group of cases the results must be considered inconclusive.

Cardiovascular Disease—This series includes three cases of endarteritis obliterans and five of hypertension. The phenomena of endarteritis obliterans in its early stages and the known etiology of arteriosclerosis suggested that “dekineticization” might be effective in the treatment of these conditions.

In this whole group of cases, however, the results have been practically negligible. In every case of hypertension there was an immediate effect upon the blood pressure, however it soon regained and retained its high elevation, while in the cases of endarteritis obliterans the disease continued to progress.

Hyperthyroidism and Hypertension—Clinical and experimental investigations have appeared to indicate that the specific agent which causes the acute exacerbations of hyperthyroidism is adrenalin. It is a common clinical observation that only such factors as cause an increased output of adrenalin can cause the specific excitation which is called a thyroid crisis, and on the other hand, we have found that the factors and agencies that either mitigate or have no effect on thyroid crises have no power to increase the output of adrenalin.

We know that in the list of classical symptoms in the syndrome of hyperthyroidism, increased pulse rate, blood pressure and increased heart rate occupy a leading place. We know that the secretion of the thyroid gland sensitizes the tissues to adrenalin and that as the thyroid secretion is decreased the response of the tissues to adrenalin is correspondingly decreased, in other words, the acute crisis of hyperthyroidism may be called an adrenalinism crisis and adrenalinism can be produced only on the background of previously increased thyroid activity. Time is lacking to offer the wealth of experimental and clinical data which support this postulate. If our conception of the rôle of the adrenals and the thyroid is correct then by removing one adrenal gland in cases of hyperthyroidism the factor of safety of the patient should be increased, that is, the removal of one adrenal like the removal of one-half of the thyroid gland should reduce the phenomena of hyperthyroidism. We have, therefore, performed this operation in four cases—adrenalectomy alone in three cases, and adrenalectomy and thyroidectomy in one case. In each case there was an immediate but not permanent effect upon the hypertension and in every case the basal metabolism was reduced. In one the basal metabolism fell at once from plus twenty-nine to plus seven and five months after operation it was still plus five. In another the patient came in with a record of a basal metabolism rate of plus forty, two weeks after operation it was plus eleven and four months after operation it was minus four per cent. In another the patient entered the hospital with a basal metabolism rate of plus twenty—leaving with minus two. In three cases in which the thyroid gland was not removed the gland diminished in size and grew firm in texture, and of equal significance, although the operation was much more severe and of longer duration than a thyroidectomy, there was but little post-operative reaction, that is, little so-called post-operative hyperthyroidism.

These operations have been performed too recently for the results to be considered as end results. This is offered only as a temporary report.

For adrenalectomy the patient is placed in the "kidney position" and a left oblique lumbar incision is made, the incision being carried down through

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the subcutaneous tissues and muscles to the kidney. A bloodless field is maintained throughout the operation and long instruments and flexible retractors are employed. When the kidney is reached the perirenal fat is detached from the upper pole, and the adrenal gland can then usually be readily identified by palpation and by observation of its specific yellow color. The adrenal artery is extraordinarily large.

There is usually a marked fall in the blood pressure during and immediately after operation—this lasts for some hours, sometimes for days, and it is a curious observation that the fall is greater at the radial pulse on the side on which the operation is performed. We have not observed any pigmentary change in any case and the removal of a single gland apparently does not even approach the margin of safety.

Excision of the cervical sympathetic is made through the usual collar incision employed for thyroidectomy. The carotid sheath is divided on each side, the cervical sympathetic nerve being identified without difficulty.

There has been no operative mortality in any of these groups of cases.

SUMMARY

Twenty-nine cases are reported in which an attempt has been made to treat certain diseases which are apparently related to adrenal activity by adrenalectomy alone, by adrenalectomy associated with thyroidectomy and sympathectomy, or by sympathectomy alone (in two cases).

This series includes thirteen cases of epilepsy, four cases of neurasthenia, three cases of endarteritis obliterans, five cases of hypertension, four cases of hyperthyroidism with hypertension.

The results of the treatment of endarteritis obliterans and of hypertension were negligible, and they were inconclusive as far as the treatment of neurasthenia is concerned. The results of the combined operations in cases of epilepsy are hopeful. The end results of the treatment of hyperthyroidism by adrenalectomy cannot yet be given but the early results show marked improvement.

END RESULTS OF PERIARTERIAL SYMPATHECTOMY

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IN 1913, Leriche called our attention to this procedure and in 1921, before this Association, he reported the results in 64 operations. His papers and those of his pupils have been very numerous and have stimulated the greatest interest in the peripheral sympathetic nervous system, rather dormant from the standpoint of practical surgery except for the work on the cervical sympathetics by Jaboulay, Jonnesco and others. Briefly, periarterial sympathectomy is done to effect a temporary vasodilatation of the peripheral circulation distal to the point of operation. Apparently it exerts some trophic influence on the tissues as well and there is evidence to show that sometimes an effect is exerted other than on the arterial tree manipulated. The effect on sensory relations is also positive but imperfectly understood. A great deal of controversy has arisen as to its mode of action and some have denied that it could have any effect but Leriche has brought forward much proof and in a recent paper (1927) believes that the classical ideas of the pathways of vasomotor impulses must give way to the belief that intramural peripheral centres are essential for the control of the circulation. I am unable to venture any opinion on the probability of his suggestion.

The reports in the literature vary from the recording of utter failure to miraculous cures and apparently something in the individual case determines the result, something which we are unable to foresee or predict. Many of the operations have been done without possibility of good result and some surgeons have condemned the operation on the basis of failure in a poorly selected group of cases. I have thought it worth while to record my experience based on ninety operations on seventy-two patients. The percentage of failure has been high, but in a few cases the result has been so satisfactory as to make the venture worth while. The variety of diseases for which the operation has been undertaken covers a wide range but certain groups can be established.

TABLE I

Total of Patients Periarterial Sympathectomy

December, 1919–March, 1928 90 operations, 72 patients

Disease	Cases	Relieved
Thrombo-angitis obliterans	17	2
Arteriosclerotic gangrene (senile and diabetic)	12*	2
Raynaud's disease	3	2
Scleroderma	3	0
Trophic ulcer	10	6
Leg ulcer	7	5
Painful stump	4	2
Miscellaneous	16	6

72 patients, 25 successful (34.7 per cent)

* One death (1.4 per cent)

Arteriosclerosis with Gangrene—Periarterial sympathectomy seems to have been practiced many times for the relief of the pain, and in the hope of checking the gangrene in the senile type of gangrene and in the diabetic. In my own experience there is no warrant for the operation except possibly for one indication. Sometimes an arteriosclerotic extremity is painful and the foot is cyanotic but gangrene has not developed. The case is apt to resemble Buerger's disease but other signs are lacking. Buerger has described such cases under the term vasoneurosis with organic arterial disease. He believes that the tip gangrene may be the result of a vasomotor neurosis independent of the obliterated main vessels. I have ascribed the recovery in one case to the action of the sympathectomy but Buerger suggests that, "following or without the use of the Leriche operation of decortication of the femoral artery, but aided by detachment of the dead epidermis and multiple puncture of the exposed corium, gradual restitution takes place."

Sympathectomy has usually relieved pain to a considerable degree in early cases of this type but I do not believe that it checked the gangrene in any case. The same may be said of the diabetic foot. In one case sympathectomy relieved pain and partial amputation of the toe was followed by recovery but Stetten a few years ago showed an excellent series of results from conservative measures alone. In arteriosclerosis the operation is supposed to be indicated on the basis of a spasm in the collaterals due to the irritation of the gangrene which is superimposed on the mechanical obstacle. I believe that if the sympathectomy is done in these cases we should also ligate the artery as proposed by Dean Lewis.

Thrombo-angitis Obliterans—Buerger's disease is well known but it is well to recall that the essential lesion is an occlusive thrombosis of the arteries and veins. Beginning as an acute process a stage is reached after a time in which the clot is organized and canalized, and there is development of fibrotic tissue in the adventitia that binds together the artery, vein and nerves. The intense rubor with the foot dependent is due to the occluded artery but gangrene is postponed by reason of the collateral circulation which easily develops in young individuals. Pain is the predominant symptom and no doubt is due partly to the neuritis induced by the stagnation of metabolic products and partly to the neuritis from the periarterial inflammation.

I do not see how it is possible to effect any vasodilatation in these vessels by sympathectomy, and unless the dorsalis pedis pulse is patent I believe the operation is useless for this purpose. The suggestion of Dean Lewis to ligate the superficial femoral so as to force and increase the collateral circulation has a better basis. After a fair experience in the treatment of this disease with hypertonic saline injections, sympathectomy and lately, with typhoid vaccine I do not believe that any treatment makes an appreciable improvement in the peripheral circulation. On the other hand all of them do something for the relief of pain and if this can be accomplished the amputation is postponed. Silbert finds that 77 per cent. come to amputation within

five years from the onset of symptoms and he deprecates the advocacy of any treatment which claims cure after an insufficient time has elapsed

Fifteen cases of Buerger's disease have been subjected to sympathectomy. If permanent relief of pain and maintenance of the integrity of the limbs be accepted as criteria for cure we have had only two successful results. In most cases temporary relief of pain was obtained but relapse occurred after a few weeks or the oncoming gangrene necessitated amputation. In one patient sympathectomy was done at the time of amputation through the leg below the knee and the stump healed perfectly.

TABLE II

Thrombosis and Gangrene—Buerger's, Senile, Diabetic

	Cases	Relieved	Per cent
	29	4	13.8
1 Typical Buerger's	Gangrene toe		Well 2 years later
2 Typical Buerger's	Early		Well 6 years later
3 Diabetic gangrene	toe		Well 2 years later
4 Arteriosclerosis	Erythromelalgia		Well 1 year later

Raynaud's Disease is supposedly a disturbance of the vasomotor mechanism in which gangrene is a terminal phenomenon. The essential features of the disease are well known and need not be repeated here. Many cases of supposed Raynaud's disease are really Buerger's disease. A number of successes and an equal number of failures have followed sympathectomy and one can theorize for or against the operation. Two of the three cases reported in this series have done well although the period of observation six months, in one was very short. In the other, six years has elapsed and she is still well.

Scleroderma, in which the lesion was in the hands, seemed to indicate a try at brachial sympathectomy but nothing was attained except that in one case the patient seemed to improve for a number of months only to relapse.

Trophic Ulcer.—Refractory ulceration, probably due in most instances to trophic influences, has furnished a fertile field for this operation, and in those series of cases reported after a short interval the incidence of cure is high but after a time many will be found to relapse.

TABLE III

Trophic Ulcer Periaxillary Sympathectomy

Following	Cases	Relieved
Frost bite	2	1
X-ray burn	1	0
Radium burn	1	0
Trauma	3	3
Multiple neuritis	1	1
Hemiplegia	1	0
Spina bifida	1	1
10 cases, 6 successful (60 per cent)		

END RESULTS OF PERIARTERIAL SYMPATHECTOMY

The rationale of the operation is based on the fact that irritative nerve lesions can produce changes in the walls of the arteries supplied by the affected nerves. Hyperemia and trophic influences are the factors affecting the ulcer. It is necessary to remove, if possible, the irritative focus in order to get an effect from sympathectomy. A fairly wide excision of the ulcer, excision of a neuroma, plastic work on scars, etc., must accompany the sympathectomy.

In one of my cases, an ulcer of the heel secondary to a leg laceration, recurrence occurred after two and a half years, with immediate healing after excision of the scar, since which time, three years ago, the ulcer has not recurred. The frost bite ulcer has been well for one year, the spina bifida case with ulcer on the foot, existing for four years, has been well for fifteen months.

The leg ulcers were of the varicose type in six instances and five were cured by sympathectomy, excision of the ulcer and skin grafting. Perhaps the sympathectomy could have been omitted but I feel that it influenced the quick healing and permanent results. One syphilitic ulcer was refractory. The painful stumps gave 50 per cent of success. It is best to combine a stump trimming if the end is conical, and if a neuroma is suspected I cut the sciatic nerve just above the popliteal space and dissect out the distal end bearing the neuroma.

TABLE IV

Miscellaneous Periarterial Sympathectomy

For	Cases	Relieved
Cervical rib	1	1
Causalgia	3	0
"Thermalgia"	2	1
Arthritis deformans	2	1
Painful osteoperiostitis	1	1
Intermittent claudication	1	0
Painful scar	1	0
Edema and phlebitis	1	0
Trophic edema, hands	1	0
Eczema, hand	1	1
Trophic contractures	1	1
Arterial thrombosis	1	0

16 patients, 6 successful (37.5 per cent.)

Miscellaneous—In the literature the lesions considered as indications for this operation are almost innumerable. In this series a successful outcome was obtained in six cases, all of extreme interest. The patient with cervical rib suffered from attacks of cold, cyanotic fingers followed by tip gangrene and pain. Sympathectomy effected complete relief of pain and improvement in the circulation. One week later I removed the cervical rib. His fingers healed and he is now perfectly well nearly seven years since the operation. The case termed "Thermalgia" was most interesting but will be detailed in the paper. The arthritis deformans patient was a physician, bedridden with almost universal involvement of his joints. He suffered

from severe pain in the feet and had a chronic paronychia in several toes, Sympathectomy was done one side and the relief was so great that he insisted upon having the operation done on the other sides. He remained free from pain and with healed toes until his death one year later. The bone case suffered from pains in the leg as a result of an old chronic osteoperiostitis. Sympathectomy gave permanent relief. The fifth successful case in this group had an eczema of the hands of long duration. The operation cured him and he remained cured up to the time of his death from an œsophageal lesion about four years later. The trophic contractures occurred in a baseball player who ascribed them to the effect of his baseball shoes. There was an element of neurosis in this case but the operation resulted in normal feet and apparent cure after two years.

In this brief review no attempt has been made to cover the subject completely. The operation has given an impetus to the study of the sympathetic nervous system and for this one should be grateful to Leriche. Whether or not the operation will stand the test of time is uncertain. Cervical and lumbar ramisection are being advanced for Raynaud's disease and for thrombo-angutis obliterans. However, I believe that for the various refractory ulcers of the extremities, particularly those having trophic influence, the operation will prove useful and at any rate it is relatively harmless and easily performed under local anæsthesia. Certainly, some brilliant cures have been obtained and many of the failures can be attributed to faulty selection or a failure to remove the irritating lesion.

LUMBAR SYMPATHETIC GANGLIONECTOMY AND RAMISECTOMY FOR CONGENITAL IDIOPATHIC DILATATION OF THE COLON

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THE results obtained from lumbar sympathetic ganglionectomy and ramisection in the treatment of two patients suffering from congenital idiopathic dilatation of the colon has prompted this report. The terms megacolon, giant-colon, achalasia of the rectum, and congenital idiopathic dilatation of the colon (Hirschsprung's disease) are insufficient to describe the character of the disease. Megacolon has come to mean a dilated hypertrophied colon resulting from some interference with the normal peristaltic function, but does not indicate whether it is of mechanical or neurogenic origin. Since the advanced degrees of each type will probably require different operative procedures, a more accurate classification will be necessary.

Because of the difficulty in many cases of demonstrating mechanical obstruction, at the time of the abdominal exploration, it is fair to assume that the coordinating mechanism of the rectum and sphincter has been disturbed^{1, 2, 4, 6, 12, 13, 19, 22, 24}, and if similar results are accomplished by operations on the lumbar sympathetic trunk a word or phrase should be coined to describe this group of patients.

We believe that congenital megacolon, and megacolon acquired in early life, without obvious mechanical obstruction, are due to hyperactivity of the sympathetic innervation of the rectum, since one is unable to demonstrate any mechanical block in the rectum or anus, and since there is a dual innervation of the rectum and anus with parasympathetic and sympathetic fibres. The motor impulses to the longitudinal muscle fibres of the rectum are supplied by the parasympathetic and the motor impulses to the circular muscles of the rectum are supplied by the sympathetic, partially arising from the lumbar rami communicantes, passing down through the sympathetic trunks, the hypogastric, and the pelvic plexuses. It is impossible to determine whether this hyperactivity is due to an irritating lesion of the ganglia of the post-ganglionic or the pre-ganglionic fibres, or is of central origin, in all probability it is of central origin.

REPORT OF CASES

CASE 1—A boy, aged eleven months, was admitted to the Section on Pediatrics of the Mayo Clinic, June 16, 1926. At birth, he weighed eight pounds. He was breast-fed for three or four days only and was then placed on various kinds of modified milk.

The mother said he had been more or less constipated from birth, with attacks of diarrhoea every two or three weeks alternating with periods of freedom from diarrhoea. On admission he was underweight and undernourished. His weight was 6.8 kg, his height was 67.5 cm.

The child was pale, and the general musculature was poorly developed. The abdo-



FIG. 1.—(Case II). Left anterolateral view of a child aged six years with congenital idiopathic dilatation of the colon prior to bilateral lumbar sympathetic ganglionectomy and ramisectomy.

men was a typical "pot belly" type, the intestines were distended with feces and gas. Neither the spleen nor the liver could be palpated. He had seven teeth. The cervical lymph-nodes were slightly enlarged. Further investigation into the history disclosed that the mother had noticed that the child's abdomen had been distended from birth, but she had been unable to interest physicians in the condition, even though it was necessary to give enemas almost every day, besides liquid petrolatum and cathartics in order to move the bowels.

The child was placed in the hospital on forced feeding, physiologic sodium chloride solution subcutaneously and five drops of tincture of belladonna by rectum three times a day. Several bowel movements of clay-colored fluid stools followed. A transfusion of 120 cc of blood was given June 22. A consultant advised continuation of the enemas and forced feeding, believing that the child's condition did not warrant ileosigmoidostomy at that time, although he might be able to withstand ileostomy. When he was dismissed at the end of three weeks, he was considerably improved, and the abdomen was smaller. Instructions were given to the mother with reference to feeding, medication, and bowel irrigation.

In October, 1926, the mother reported that the child was losing weight, that his color was poor, and that enemas failed to produce the desired result. She was instructed to bring him back to the clinic for further observation and treatment which she did May 27, 1927. She said that after their return home in July, 1926, the child had improved for about two months on the feeding of reinforced milk and the two enemas daily. At the expiration of that time, difficulty with the bowels again developed. In September, the local phy-

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sician was obliged to remove an impaction, following which enemas were again given. For a time, between the months of February and May, 1927, the bowels moved normally but in May, 1927, from two to three enemas were given daily, in an effort to secure a bowel movement, when these, too, proved futile, and it became necessary for the physician to remove the feces with an instrument four or five times during the two or three weeks previous to readmission. Just prior to admission there appeared to be more distention from gas, and peristaltic waves were visible through the abdominal wall. Enemas caused gas to escape but not stools. The abdomen increased from 52.5 to 67.5 cm. in circumference.

The child was very much better nourished than on the first admission, however, the abdomen was markedly enlarged, and peristaltic waves were visible. Rectal examination was made with ease and was negative. Rontgenograms showed dilatation of the descending colon and sigmoid. The specific gravity of the urine was 1.016, it was acid in reaction, sugar was not present, but an occasional pus cell was found. The haemoglobin was 61 per cent. Erythrocytes numbered 3,940,000 and the leucocytes 8,500, the color index was 0.7. A differential count showed lymphocytes 64.5 per cent, neutrophils 29.5 per cent, large morphonuclear lymphocytes 0.5 per cent, transitional cells 1.5 per cent, eosinophils 2.5 per cent and basophils 1.5 per cent.

It was obvious that the child was suffering from congenital idiopathic dilatation of the colon, involving chiefly the sigmoid and the descending colon. While he could be kept moderately comfortable on active treatment in the form of feedings of reinforced milk, and the use of enemas of oil, physiologic sodium chloride, and soapsuds, the moment this stringent program was modified mechanical aid was necessary to effect evacuation. In view of this, the child was prepared for surgical treatment. On June 7, 1927, one of us (Adson) performed left lumbar sympathetic ganglionectomy and ramisectomy. The second, third and fourth lumbar ganglia with the sympathetic chain were removed (the ganglia in one strip); all of the rami coming to and from the ganglia were divided and the sympathetic trunk with the ganglia from just below the first lumbar ganglion to a point below the fourth lumbar ganglion removed.



FIG. 2—Anterior view of patient shown in Figure 1.



FIG 3—Drawing of the colon made at the time of operation, illustrating the portions of bowel involved and the absence of mechanical obstruction in the rectum. Patient shown in Figures 1 and 2.

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through a transperitoneal Adson approach† Unilateral sympathetic ganglionectomy was performed because the lesion was of moderate degree and left-sided

Exploration of the abdomen revealed a more or less classical megacolon, which began from below, slightly above the juncture of the rectum and sigmoid, at about the upper level of the true pelvis and extended upward, involving the descending colon and about three-fourths of the distal portion of the transverse colon The right hepatic flexure, the ascending colon, the cæcum and the rectum were normal in size and normal

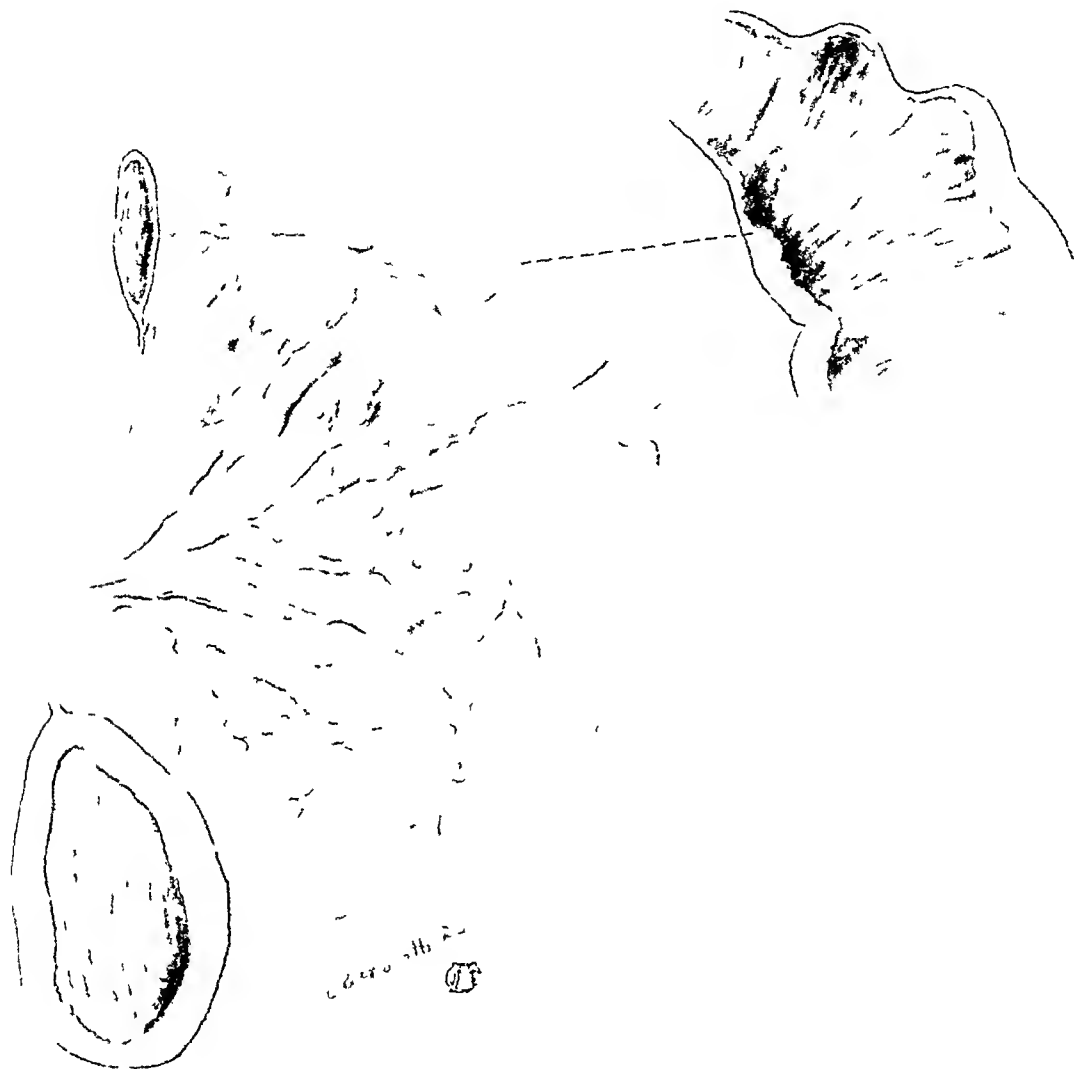


FIG 4—Drawing illustrating the absence of mechanical factors limiting the proximal dilatations of the transverse colon

to palpation, the distended portion was several times larger than normal, the longitudinal bands were obliterated by irregular striations, as is so often seen over the entire surface of the involved bowel, on palpation, the wall was found to be moderately thickened, apparently a proportionate increase in all dilated and hypertrophied layers of the large bowel On manipulation of this portion, a peristaltic wave would be initiated downward, the application of a hot sponge would produce a similar retraction and in comparing the activity of the normal portion of bowel with that of the diseased portion, it was obvious that the diseased portion was more active than was the normal The

† This operation was first performed March 10, 1925 It was discussed in a symposium on ramisection before the American College of Surgeons in the autumn of 1925, and published later in *Surgical Clinics of North America*, 1925 vol 1, pp 777-789

sigmoid and the descending colon were markedly adherent to the muscles in the iliac fossa and in the lumbar area, giving evidence of some previous inflammatory reaction

The patient's post-operative course was uneventful. The temperature rose on the morning of the second day to 103.6° , returned to normal in the evening, rose to 100° on the third day, and again returned to normal in the evening. From that time until his dismissal, on the twenty-first day after operation, the temperature remained normal. Fluids only were given for the first few days, semi-solids with fluids were given on the third and fourth days, he was then placed on a regular diet. The wound healed by primary intention.

On the third day after operation a mild enema was given, with a return of flatus and bowel material on the morning of the fourth day. The bowels had moved spontaneously before the enema was given. On the fifth day the bowels moved spontaneously immediately on insertion of the rectal catheter, previous to administration of the soapsuds enema. The catheter was withdrawn and, after expulsion of the formed stool, it was reinserted and a small enema was given, with further evacuation. Following this a small oil-retention enema was administered daily for the purpose of lubricating the mucous membrane and softening the feces, preparatory to discontinuing the soapsuds enemas. Later, small quantities of milk of magnesia were prescribed, this to be continued after the child's dismissal from the clinic. In a letter dated July 7, 1927, the mother said that the child was having normal stools independent of enemas and laxatives. The abdomen was distended and flatus was passing freely. He had gained in weight and seemed "wonderful" in every way. We advised the discontinuance of soapsuds enemas, the administration of milk of magnesia occasionally, the continuation of the oil enemas for a time then gradually decreasing them. In a letter dated August 8, the mother

FIG 5—Patient shown in Figures 1 and 2 four months after bilateral lumbar sympathetic ganglionectomy and ramisectomy

stated that the child's general condition had improved steadily, that he was passing from one to two normal stools daily, and that during the two weeks prior to her report it was necessary to administer only one soapsuds enema and two oil enemas. A letter dated April 10, 1928, reported that the child was doing nicely but was unable at that time to return for Röntgen-ray examination.

CASE II—A child, aged six years, was admitted to the Section on Pediatrics, November 7, 1927. The chief complaint was enlargement of the abdomen and consti-

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pation The child had been a normal, full-term baby weighing eight pounds at birth. He was breast-fed for six months, had his first tooth at thirteen months, walked at eighteen months, and talked at fifteen months. He had been constipated from birth, for a week following delivery the bowels did not move. From that time until he was six months of age he was given daily potions of castoria, olive oil, and enemas. When he was six months of age, all measures had failed to bring about evacuation of the bowels for three days. The mother stated that the child had never had a normal bowel movement, that the abdomen had been markedly distended since he was six months of age, and that frequently he was taken to the hospital for special treatment of purgation, massage, enemas, and so forth, to empty the distended bowel. The usual routine was continued at home in the intervals, with only partially good results. There had always been much flatulence, and vomiting occurred whenever the abdomen was distended. Nocturnal enuresis had not been present, diurnal enuresis had occurred daily.

On admission, (Figs 1 and 2) the child's height was 107.5 cm, his weight 22.2 kg (normal weight 18.6 kg), the pulse was 90 and the temperature 98.8°. The chest measured 57.5 cm in circumference, and the abdomen 68.7 cm, but the mother stated that it measured 87.5 cm in circumference when the constipation was severe. The child appeared to be well developed, and fairly well nourished. The outstanding feature in the examination was the markedly distended abdomen. On palpation, the distended cæcum and transverse colon could be made out readily, peristaltic waves were also visible. Neither the spleen nor the liver could be palpated. The lower border of the wall of the chest had an outward flare. The tonsils were slightly enlarged and injected, and there was some mucus in the pharynx. A discharge from the right eye was due to dacryocystitis. The specific gravity of the urine was 1.030, it was acid in reaction, contained a faint trace of albumin, but did not contain casts or cells. The hæmoglobin was 60 per cent, the erythrocytes numbered 3,740,000, and the leukocytes 7,600, the color index was 0.8. Röntgenograms of the rectum and sigmoid showed dilatation, graded 4, and some distention in the transverse colon.

Because of the persistent constipation and abdominal distention, medical treatment was carried out in an attempt to evacuate the sigmoid and colon thoroughly and, at the same time, to maintain a high calorie nonresidue type of diet in preparation for some form of surgical treatment. Various consultants in the clinic offered suggestions with reference to treatment for pre-operative preparation and surgical intervention. An enema was given from one to three times a day together with occasional doses of castor oil and 5 minims of pituitrine every four hours, for two-day periods, and occasionally

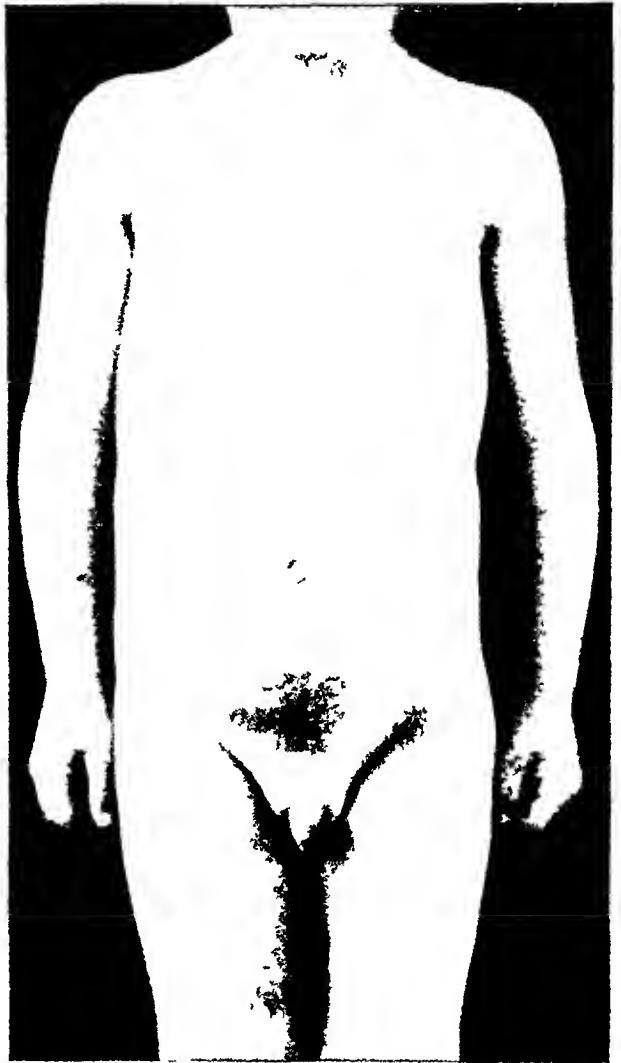


FIG. 6—Anterior view of patient shown in Figure 5

hypodermic injection of atropine. The diet consisted of soups, bouillons, broths, and tomato juice. A little later, after the abdomen had become somewhat reduced in size, cream soups, gelatin, and butter were added. The diet was reinforced at all times with

candy and sugar and, just previous to operation, scraped beef was included in the diet. Since the megacolon, in this case was more extensive than in Case I, bilateral lumbar sympathetic ganglionectomy and ramisectomy was advised and was performed on December 21, 1927 (Adson).

On opening the abdomen, (Figs 3 and 4) the dilatation and hypertrophy was found to extend upward from the rectosigmoid juncture. It was most marked opposite the middle of the sigmoid, and then tapered off toward the splenic flexure. It involved the transverse colon, but not the hepatic flexure, ascending colon, cæcum or rectum. The wall of the sigmoid was three times as thick as normal and the hypertrophy appeared to involve the serosal, muscular, and mucosal coats, equally. About 20 cm from the hepatic flexure, the hypertrophy disappeared without obvious explanation and the remaining portion of the colon was free from bands, adhesions, or any gross lesion. The initial involvement appeared to be in the sigmoid, spreading then to the descending colon, splenic flexure and to approximately two-thirds of the transverse colon. The hepatic flexure, ascending colon, cæcum, and small intestine were normal on palpation, and in appearance. The muscular contraction of the hypertrophied portion of the sigmoid, as well as that of the transverse colon, was very active, on the slightest manipulation of the bowel or application of a sponge soaked in hot physiologic sodium chloride solution, violent peristaltic waves developed. There was nothing particularly abnormal about the ganglia on either side, except possibly that the second lumbar sympathetic ganglion on the left side had more communicating rami than is usual and that there appeared to be two distinct rami extending into



FIG 7—Patient shown in Figure 5 four months after operation

the mesentery of the sigmoid, which had been reflected. There appeared to be slight enlargement of the second lumbar sympathetic ganglion on the right side. The white ramus was easily distinguishable on both sides, so that when the operation was com-

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pleted, all of the second, third, and fourth sympathetic lumbar ganglia, as well as the sympathetic trunks and all of the rami, were removed well above the second lumbar transvertebral foramen and below the fourth. The lumen of the sigmoid was from 7.5 to 10 cm in diameter, and that of the transverse colon was from 5 to 7.5 cm in diameter. The normal rectum is about 3.75 cm in diameter, and the normal descending colon about 3.75 to 5 cm in diameter.

The post-operative course was uneventful and unusually mild. On the first and second days the temperature rose to 101° , on the third and fourth days to 100° , and from then until the time of the patient's dismissal it remained perfectly normal. A small soapsuds enema was administered on the third and fifth days with return of colored fluid. By the sixth day, the child's diet had been reestablished to what it was just prior to the operation, and following the enema much flatus and fecal matter were expelled. On each subsequent day, the results became more favorable, and a spontaneous bowel movement occurred on the eleventh day. Enemas were given daily, however, until the twentieth day, when normally formed stools were passed spontaneously and without difficulty. The abdominal wound healed by primary intention, and the patient was dismissed on the twenty-fourth day.

The patient returned for examination, April 20, 1927 (Figs 5, 6 and 7). In contrast to the pasty-skinned, languid, cachectic-appearing child previous to operation, he was now vivacious, talkative, and very active, with a clear, pinkish skin, and reacting quickly to his environment. He was not constipated or

toxic and was having one and two spontaneous bowel movements each day. He climbed on the examining table with ease, and was willing and eager to cooperate. He swung over a chair on his abdomen, as if nothing had ever been wrong. The abdomen measured 65 cm in circumference, which is larger than that of the average child of six years, but there was less flabbiness of the skin over the abdomen and the tone of the abdominal muscles had improved. The lower margin of the ribs, instead of tapering in to close the thorax, flared outward, giving evidence of former pressure within the abdomen.

On percussion, tympanic notes could be heard distinctly over the transverse and the descending colon. Peristaltic waves could not be observed to correspond to any portion of the large bowel. Numerous Röntgen-ray examinations were made (Moore) to determine the status of the sigmoid, descending colon, transverse colon, and ascending colon (Figs 8, 9 and 10). A litre of barium enema, instead of remaining in the sigmoid, now filled the entire colon, as was noted in Wade and Royle's case. Active



FIG 8—(Case II) The large bowel is shown greatly dilated. Peristaltic waves are not demonstrable during examination. Note absence of haustra (November 8, 1927).

peristaltic waves traveled along the large bowel and, in passing, compressed the barium to a mere pencil-line for a distance of from 10 to 15 cm at a time. On examination under the fluoroscope after five hours, it was found that most of the barium had been expelled from the cæcum, and the ascending and transverse colon into the descending colon and sigmoid. Twenty-four hours after the original barium enema, fluoroscopic examination and plates showed that all of the barium had been expelled except for a small portion in the cæcum and sigmoid.

Surgical Procedure—The incision is made from the symphysis to a point 7.5 cm above the umbilicus, between the abdominal recti muscles and to one



FIG 9—(Case II) Marked decrease in the size of the large bowel since operation. Rhythmical peristaltic waves were seen throughout the entire large bowel, producing deep contractions, and well marked haustra (April 20, 1928).

side of the umbilicus. The sheath of the rectus muscle is subsequently opened on each side below the umbilicus and, on the left side, above the umbilicus, facilitating closure along anatomic lines. If the abdomen is extremely flaccid, it may be advisable to make an overlapping closure (C. H. Mayo type) in the external leaves of the abdominal rectus fascia. Before the peritoneum is opened the patient is lowered from the horizontal position to a Trendelenburg position, thus insuring better exposure of the lumbar sympathetic ganglia. Although a general exploration may reveal other abdominal lesions, they are not disturbed at this time since we do not want to add

the additional risk of contamination. The intestines are packed upward as is done in performing hysterectomy. It is immaterial whether one approaches the ganglia on the right or the left side first. Usually, the ganglia of the right side are more difficult to approach because of the intravertebral veins which run anteriorly and across the sympathetic trunk. It is more difficult to elevate the inferior vena cava than the abdominal aorta and the common iliac artery on the left.

In exposing the left lumbar sympathetic chain, it is necessary to loosen and elevate the sigmoid and the lower portion of the descending colon (Fig 11). This is done by incising the peritoneum superior and just

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lateral to the anterolateral border of the upper portion of the sigmoid and the attachment of the lower portion of the descending colon. When the line of cleavage is once started, the large bowel can be elevated readily and retracted with the posterior wall of the peritoneum beyond the median line, exposing the retroperitoneum, the ureter (as it crosses the bifurcation of the common iliac), the left common iliac artery and vein, the lower end of the abdominal aorta, the genitocrural nerve (which perforates the psoas muscle), the psoas muscle, the lumbar vertebrae, the lymph-nodes, and the lumbar sympathetic ganglia, trunk, and rami, which lie on the lumbar vertebrae, just mesial to the

psoas muscle. The ureter on the left side is more easily retracted mesially than laterally. It is held gently together with the colonic mesentery, the upper end of the sigmoid, and the lower end of the descending colon, in a median-line position with a sponge soaked in physiologic sodium chloride solution. The abdominal aorta is elevated and retracted mesially by finger traction on a gauze sponge. It is held by an assistant. The sympathetic ganglia, trunks, and rami are then dissected free by a wet cotton ball dissector held in thumb forceps. It is well to begin

at one or the other end of the lumbar sympathetic chain. On the left side, it is preferable to expose the fourth lumbar ganglion at the brim of the pelvis, and divide the sympathetic trunk below it. All of the rami, including those to the spinal nerves, the hypogastric plexuses, and the aortic plexuses, are then divided. The dissection is then carried upward to include the third and second lumbar sympathetic ganglia. Maintaining the sympathetic trunk and these three ganglia in continuity, the sympathetic trunk and the white ramus are divided above the second lumbar ganglion. The ganglia and the sympathetic trunk are removed in toto. The only disturbing feature which may be encountered is injury to a small intervertebral vessel or to the peritoneal vessels during the lateral dissection. All of these vessels are small, of no consequence

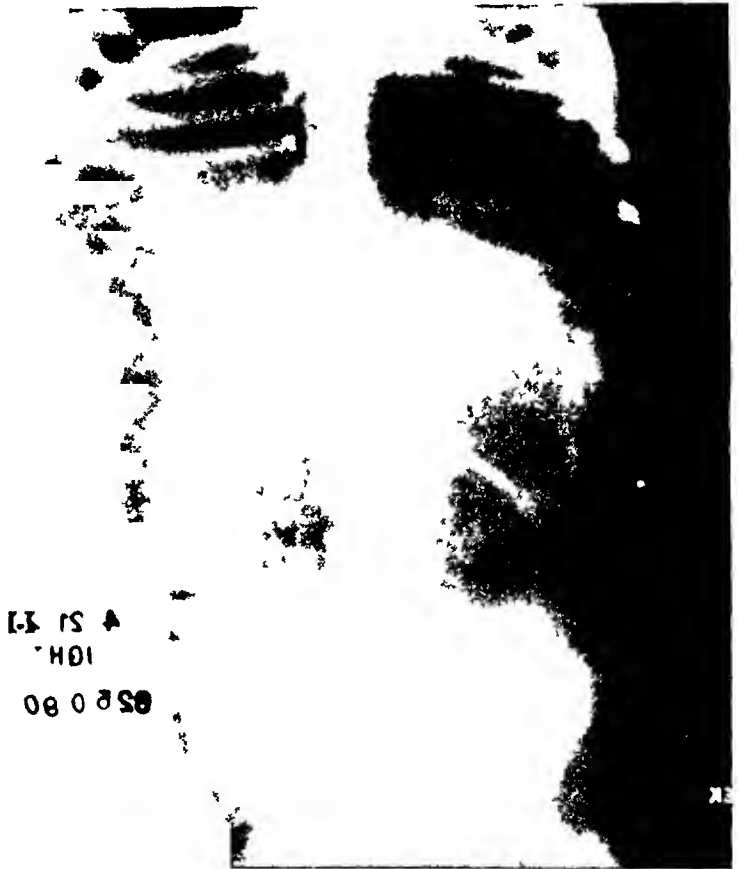


FIG 10—(Case II) The large bowel practically empty twenty-four hours after examination. Catharsis was not given, but one soap-suds enema was administered just before the plate was taken.

and may be ligated. If difficulty is encountered in the ligation of an intravertebral vessel, a silver clip may be used. Undue traction should not be exerted on any of the tissues handled, especially the mesentery leading to the sigmoid and colon, so as to avoid the possibility of rupture or thrombosis of arteries or branches of arteries supplying the large bowel.

The approach to the lumbar sympathetic ganglia on the right is similar to that on the left, except that the peritoneal incision is made just lateral to the right lateral border of the abdominal vena cava (Figs 12 and 13), and is carried downward over the right common iliac vein into the true pelvis,

upward and mesially along the root of the mesentery of the small intestine, partially across the vena cava for a distance of 15 cm from the brim of the pelvis, and downward into the pelvis for a distance of 7.5 cm. The cæcum, the small intestine, and the ureter are retracted outward and upward. The vena cava is retracted mesially, and the common iliac vein downward and mesially. Several small veins just above the brim of the pelvis on the right side may be encountered in the posterior wall of the peritoneum,

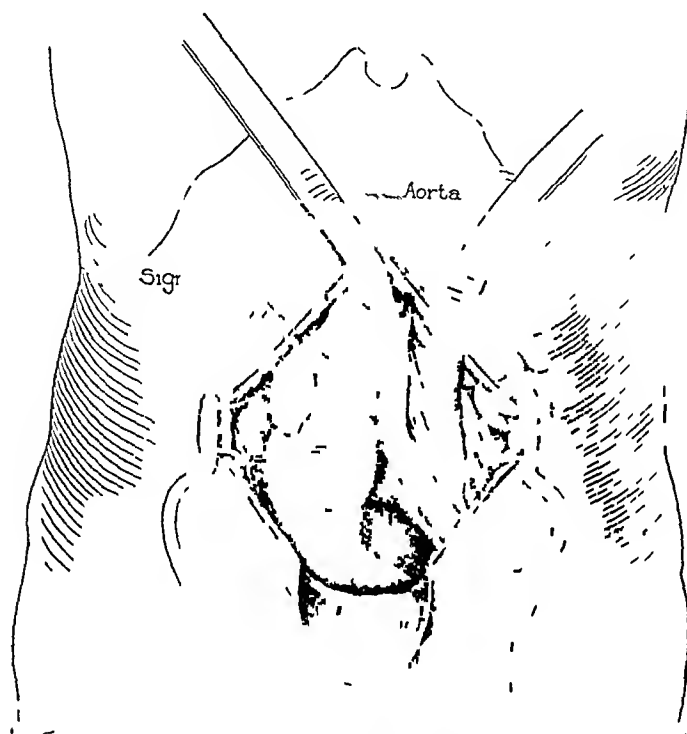


FIG. 11.—Mobilization of the sigmoid and descending colon to expose the left lumbar sympathetic trunks, ganglia and rami.

which can be divided and ligated. The further exposure and the removal of the lumbar sympathetic ganglia and division of all of the rami and the sympathetic trunk are similar to the procedures employed on the left side. However, the fourth lumbar sympathetic ganglion on the right side usually lies underneath the intravertebral vein and not superficial thereto, as it does on the left side.

The closure consists in accurate apposition of both retroperitoneal incisions to prevent retroperitoneal hernia, and accurate closure of the abdominal wall to prevent post-operative hernia.

Post-operative Care—These patients do not require any special post-operative care. However, not knowing what to expect, we were extremely cautious in the post-operative care in our two cases. Enemas of soapsuds, physiologic sodium chloride solution and oil as well as laxative were prescribed for the first patient for two months and then an oil enema occa-

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sionally Enemas of soapsuds, physiologic sodium chloride solution and oil were prescribed for the second patient for three weeks, and an oil enema daily for two months, then intermittently for from four to five months

Although the distention may recede somewhat slowly and the tone of the abdominal wall may be moderately slow in returning to normal, it is obvious, from the study of the two cases reported, that both are taking place, however, on account of the hypertrophy, the colon probably will never return to normal size

Pathology—The pathologic process is confined, usually, to the colon In one-third of the cases, it involves the sigmoid flexure only Terry reported a case in which ileosigmoidostomy had been performed, with subsequent development of mega-ileum, which would suggest strongly that a similar etiologic factor probably produced both the megacolon and the mega-ileum Fraser reported three cases of mega-ileum in children, as a result of a pathologic lesion at the ileocaecal sphincter It is apparent that in the milder cases, the dilatation and hypertrophy are confined to the sigmoid, but, as the rectal block becomes more pronounced, the process appears to extend proximally and to include the descending colon, the transverse colon, and the ascending colon It rarely involves the caecum or the lower end of the rectum The transition from an abnormally dilated portion to a normal portion is usually gradual, but may be abrupt Rarely is there any evidence of mechanical obstruction or of pronounced sphincters at either end of the dilatation in the so-called idiopathic type In mechanical obstruction with resultant megacolon the block can be demonstrated distal to the dilatation The dilatation and hypertrophy, apparently, are compensatory changes that develop in an attempt to remove the fecal content of the sigmoid The dimensions of the dilated portion vary according to the degree of obstruction whether of neurogenic or mechanical origin and have been known to reach 15 to 20 cm in diameter^{7, 9, 23} In Peacock's case the colon contained 16 litres of fecal material The walls of the involved portion of the colon are apparently proportionately hypertrophied

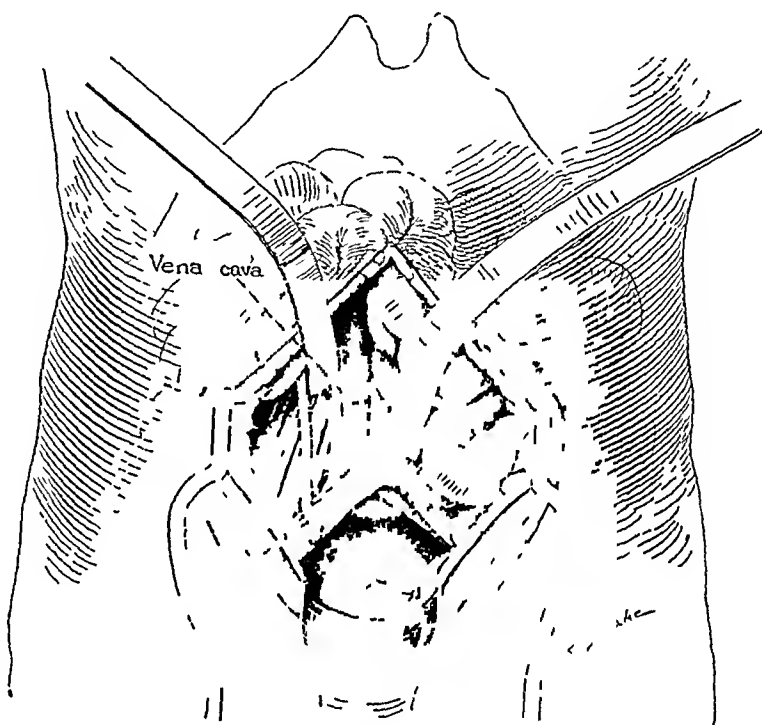


FIG 12—Mobilization of the cecum and small intestine to expose the right sympathetic trunks, ganglia, and rami

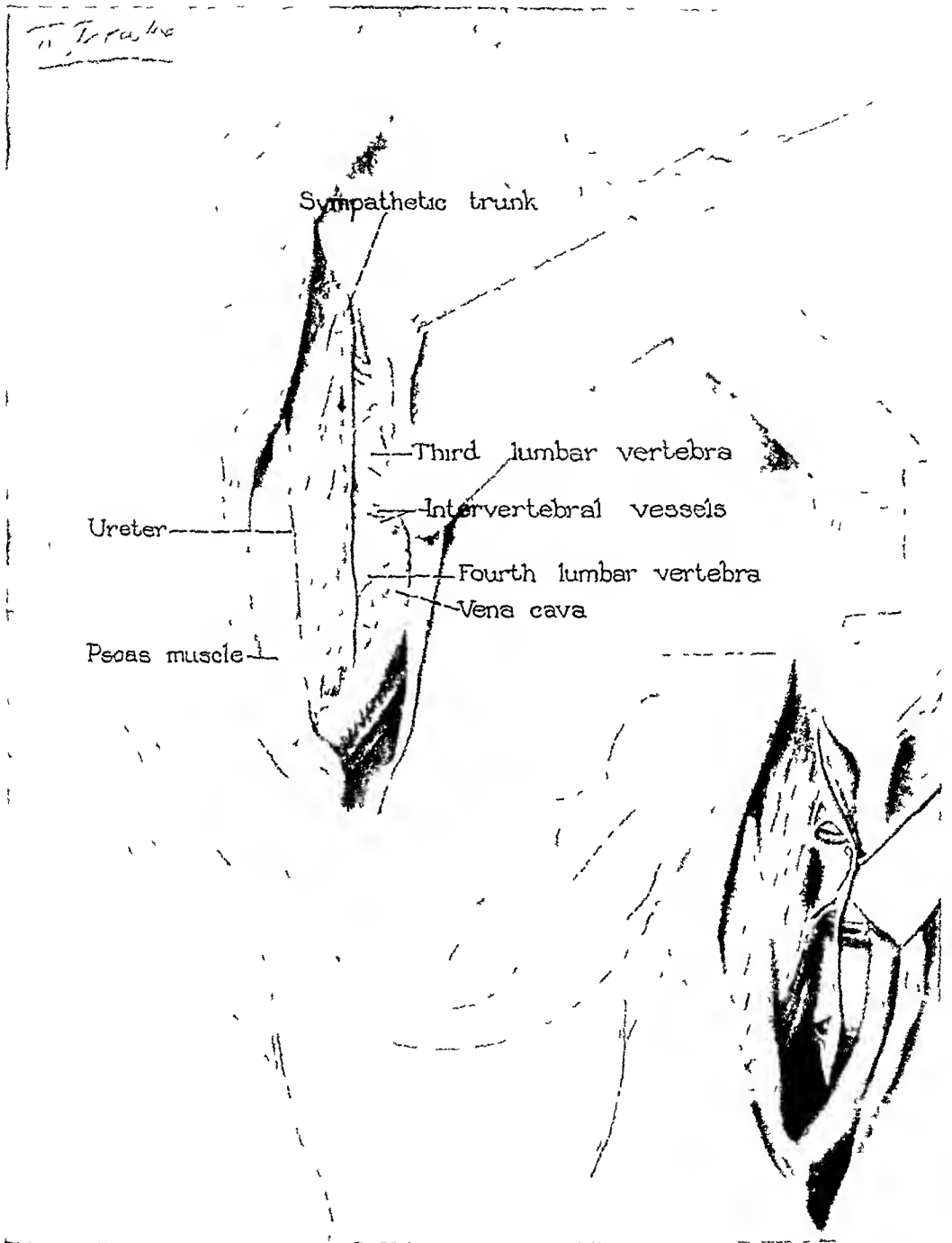


FIG. 13.—Posterior incision exposing the second, third and fourth lumbar sympathetic ganglia, sympathetic trunk, and rami

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The serous coat is usually roughened, and the tænia less pronounced, or obliterated, thus giving evidence of peritonitis as the result of necrosis from pressure. The muscular coats and the submucosal and mucosal layers are also thickened. The lymph-vessels and blood-vessels are increased in size, usually, with an increase also in the size and number of the lymph-nodes. It is often observed that the mucosa is pigmented, and it may show patches of ulceration or scars from colitis, which have developed subsequent to chemical irritation and trauma from impacted feces. The Auerbach ganglia do not show any particular change, if anything, the cells are in clumps which are slightly larger than normal.

Symptoms —The symptoms of megacolon are characteristic and striking. The two cardinal features are obstinate constipation and distention of the abdomen. In typical cases these symptoms appear during the first days or weeks of life and persist with brief periods of improvement throughout life. In some cases pronounced symptoms do not appear until later in childhood or adult life and in rare cases they are not manifest until late in life. The most striking feature is the extraordinary infrequency of the bowel movements in the absence of symptoms of acute obstruction. It is not uncommon for from three to four weeks to elapse without a bowel movement, and in a few cases three months are said to have elapsed between evacuations, as in the case reported by Gay. Ordinarily bowel movements are induced with great difficulty and large doses of drastic cathartics may be taken without producing any effect. The stools are often large, inspissated, and very malodorous. Unusual attitudes may be assumed during defecation, as leaning over a chair or the knee-chest position. At intervals there may be diarrhoea or vomiting. Ladd has called attention to the fact that daily liquid stools may pass and yet feces be retained. Abdominal distention may be present at birth to such degree as to interfere with delivery, as in cases reported by Hobbs and de Richmond. Ordinarily the distention appears within the first few days or weeks of life from the accumulation in the colon of feces and gas, and it varies indirectly with the activity of the bowels. It may be uniform and general or localized, corresponding to the position or content of the affected portion of the bowel. Correspondingly movable dulness and tympany may be elicited.

Secondary symptoms and signs which are often associated may include dyspnea, cardiac embarrassment, wide costal angle, thin abdominal wall, diastasis recti, distention of superficial abdominal vessels, displacements of thoracic viscera, hernias, audible borborygmus, œdema of the extremities, toxicosis and impaired nutrition.

Treatment —In discussing the general treatment of megacolon we quote from Judd and Thompson:

"There seems to be no successful prophylaxis against megacolon although progress may be checked by early and judicious treatment. In addition to the fact that a practical cure may be obtained in a few cases by means of medical treatment, it is also of distinct value at certain stages of the disease

and also in the preparation of patients for operation. In very young infants or in undernourished subjects operative procedures are not well borne and dietary and hygienic measures must be relied on. As pointed out by Rankin, before any surgical procedures are applied directly to the colon, preliminary emptying of the bowel is of paramount importance.

"If patients are undernourished, the establishment of hygienic measures is desirable. The diet should be nutritious and easily tolerated. For these requirements, carbohydrates and foods with adequate vitamin content are desirable. In some cases, however, increased formation of gas is noted following diets rich in carbohydrate. Certain authors advise restriction of animal protein as prophylaxis against intestinal intoxication. Lactic acid milk is often of distinct value. On the other hand, a diet high in residue may be found to promote peristalsis. Before operation, however, a diet low in residue is required. Physical measures such as exercise, massage, the wearing of an abdominal support, electricity, enemas, the use of the rectal tube and rectal instillations of oil are all of value. The drugs which may be of use include mineral oil, laxatives, tonics, including arsenic and iron, dilute hydrochloric acid, cod-liver oil, and the physiologic drugs as atropine, pituitrine and thyroxin.

"The indications for surgical treatment are given by Terry as the presence of definite obstruction and the failure of medical treatment. According to Rankin, the selection of a surgical procedure is determined by the chronicity of the condition and the presence or absence of superimposed acute obstruction. In the presence of acute obstruction, drainage is indicated, and may be accomplished by ileostomy, cæcostomy or colostomy, removal of the obstruction being a secondary consideration. In cases of chronic obstruction removal of the obstruction by appropriate means is indicated. In a few of the so-called spasmodic cases or cases of partial obstruction, dilatation or division of the sphincters or a stricture, if present, has given apparent good results. In the idiopathic type of cases many procedures have been employed. Among the earlier palliative measures used were intestinal puncture, colotomy, colopecty, coloplasty and plication of the colon which did not afford definite results. Enterostomy, appendicostomy and colostomy are of distinct aid in emergency drainage, preliminary to resection, or for the purpose of through-and-through irrigation of the affected bowel. Of the more radical procedures, Mirizzi recommends total colectomy on the basis of recurrence in 25 per cent of his cases. Exclusion of the colon by ileosigmoidostomy is strongly advocated by certain observers. But this procedure alone does not prevent accumulation of feces in the excluded loop. To overcome this objection Sistrunk recommends section of the sigmoid above the anastomosis and utilization of the proximal stump for colostomy with colectomy being performed later if desirable. Rankin recommends exteriorization by the Mikulicz method when possible, but otherwise prefers the intraperitoneal resection using the aseptic basting stitch method of Kerr."

Analysis of the Sixty-five Cases—Judd and Thompson have reviewed

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sixty-five cases of megacolon seen at the Mayo Clinic between January 1, 1908 and January 1, 1928. Of this number eight were the so-called pseudo-megacolon or secondary type and fifty-seven were idiopathic. Other congenital anomalies were associated in nine of the cases. However, five of the fifty-seven cases of megacolon had congenital deformity of the anal canal or lower portion of the rectum. While this deformity may have been a factor in the production of the condition, the megacolon persisted after the deformity was corrected. Forty-two of the fifty-seven typical cases of megacolon occurred in males, and fifteen in females.

Infrequency of bowel movements was stressed in thirteen of the fifty-seven cases. In twelve of these, the period between bowel movements ranged from five to seventy-two days. One patient, a girl aged twenty-one, stated that she had gone as long as nine months without defecating but that ordinarily movement of the bowels occurred every one to three months.

In twenty-seven of the fifty-seven cases of idiopathic megacolon medical treatment was given. In thirty surgical treatment was given. Sixteen of the twenty-seven patients who had been treated medically were traced. Thirteen of the sixteen had improved and three had subsequently died.

Several types of surgical procedure were employed in the thirty cases in which operation was performed. In seven cases appendicostomy or cæcostomy was performed to facilitate through-and-through irrigation of the colon. Of five of these patients whose follow-up records are complete, one is cured several years after closure of the appendicostomy opening, one improved after irrigations, one died from intoxication following operation and two died at periods of several months after operation from unknown causes. Short-circuiting procedures were employed in six cases, this included ileostomy in one case and ileosigmoidostomy with exclusion of the affected colon in five cases. The records were complete of five of these patients. Two were cured eight and thirteen years after operation, one was improved, and two had died from post-operative complications. In fourteen cases, radical resection of the affected colon was performed. Complete records were obtainable in thirteen. Eight patients were cured six to eighteen years post-operatively, one had not improved, and four died post-operatively. The Mikulicz operation was employed in eight cases, total colectomy in three, and anterior partial resection in three. In one of the earliest cases fecal impaction was broken up intraperitoneally and this procedure was followed by improvement. In our two cases lumbar sympathetic ganglionectomy and ramisectomy was performed with entirely satisfactory results.

To summarize the results of surgical treatment in the twenty-six cases in which the records were complete, thirteen (50 per cent of the patients) were cured, three (11.5 per cent) were improved and a like number were not improved. In other words, 61.5 per cent of the twenty-six patients were cured or improved, and 38.5 per cent had died or were unimproved. From this analysis it would appear that while surgery of the colon offers some pros-

pect of a cure of megacolon, nevertheless, it is attended by a great hazard and any treatment that offers a chance of relieving the condition with less risk is certainly justified

SUMMARY

In view of the diversity of opinions concerning the etiologic factors and treatment of megacolon, we have been stimulated to follow the suggestion in Wade and Royle's original article and by a personal report from Wade to Alvarez of our staff. Wade reported four additional cases of megacolon, in which he had operated. In two of these the results were as satisfactory as the one reported by Wade and Royle. In the other two the results were unsatisfactory. Wade commented on the operation and stated that these were extremely difficult cases to treat and that there was some uncertainty about the completeness of the operation.

In searching for an explanation of the results obtained in the two cases reported here it is found that many men have attributed congenital idiopathic megacolon to a neuropathic cause suggesting a disturbance in the coordinating mechanism of the rectosigmoid sphincter, or a disturbance in the anal sphincter. According to Fraser and Hurst, failure to relax is the chief factor. According to Royle and Hunter, a postural tone has been superimposed on the rectal mechanism which has disturbed the coordinating mechanism. The latter view had previously been suggested by Gaskell and Sherrington.

Cunningham, in his text-book on anatomy, stated: "The pelvic part of the sympathetic trunk, like the cervical and lower abdominal portions of this system, receives no white rami communicantes from the spinal nerves. The visceral branches (pelvic splanchnic) of the third sacral nerve, and usually, also, the second or fourth sacral nerve, enter the pelvic plexus without being directly connected with the sympathetic trunk. These nerves, however, are to be regarded as homologous with the white rami communicantes of the thoracolumbar nerves (abdominal splanchnic). They convey to the pelvic viscera (1) motor and inhibitory fibres for rectum, uterus, and bladder, (2) vasodilator fibres for the genital organs, and (3) secretory fibres for the prostate gland.

"This portion of the sympathetic trunk is placed on the pelvic surface of the sacrum, medial to the anterior sacral foramina. It is connected above by a cord with the abdominal portion of the sympathetic, and below it ends in a plexiform union over the coccyx with the trunk of the other side, the two being frequently connected by the ganglion impar or coccygeal ganglion. The number of ganglia is variable, there are commonly four. They are of small size, gradually diminishing from above downward.

"Central communicating branches arise irregularly in the form of gray rami communicantes from the sacral ganglia, which join the anterior rami of the sacral and coccygeal nerves.

"Peripheral Branches of Distribution —1 Visceral branches of small size

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arise from the upper part of the pelvic sympathetic trunk, and join the pelvic plexus. 2 Parietal branches, also of small size, ramify over the front of the sacrum, and form, in relation to the middle sacral artery, a plexiform union with branches from the sympathetic trunk of the other side.

"The nerves of the rectum come partly from the sympathetic and partly from the cerebrospinal system. The sympathetic fibres are derived from the inferior mesenteric plexus, through the superior hemorrhoidal nerve and the corresponding plexus, and from the upper and lower divisions of the hypogastric plexus, the former accompanying the superior hemorrhoidal, the latter the middle hemorrhoidal vessels, to the rectum. The cerebrospinal fibres arise from the second, third, and fourth sacral nerves soon after these leave the sacral foramina (and constitute the 'pelvic splanchnics' of Gaskell). They run forward in the pelvic connective tissue, and joining the pelvic plexuses, reach the side of the rectum. Fibres of the inferior hemorrhoidal branches of the pudendal nerve (third and fourth sacral) are also distributed to the lower part of the anal canal as well as to the external sphincter.

"It has been shown by experiments on animals, that the cerebrospinal nerves (from the second, third, and fourth sacral) convey motor impulses to the longitudinal fibres, but inhibitory impulses to the circular muscular fibres. In like manner the branches from the sympathetic convey motor fibres (derived from some of the lumbar rami communicantes) to the circular muscle, and inhibitory fibres to the longitudinal muscle of the rectum.

"The reflex centre which governs the action of the sphincters and the muscular fibres of the rectum ('defecation centre') is situated in the lumbar region of the spinal medulla, and appears to be capable of carrying out the whole act of defecation even when separated from the brain."

In reviewing nerve supply of the rectum, calling to mind that gross pathologic change is not found in the rectum in cases of idiopathic megacolon and, since both of our patients were relieved by lumbar sympathetic ganglionectomy and ramisection, we believe that relief obtained by reestablishment of coordinating mechanism is due to reduction of the sympathetic stimuli coming from lumbar rami communicantes through the hypogastric and pelvic plexuses.

The result is not necessarily due to division of the white ramus or to removal of the lumbar ganglia. It is probably due to a thorough interruption of the sympathetic chain below the last white ramus, preganglionic fibre to the lumbar ganglia. The division of the lumbar sympathetic chain diminishes the sympathetic stimuli to the circular muscles of the rectum. Because of these facts, we believe that so-called idiopathic, congenital or acquired megacolon is the result of hyperactivity of the sympathetic innervation of the rectum, and that when symptoms of obstruction and toxicosis develop, division of the lumbar sympathetic trunks should be considered.

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EFFECT OF SYMPATHECTOMY UPON THE PAIN OF ORGANIC DISEASE OF ARTERIES OF THE LOWER LIMBS AND FOR OBSCURE ABDOMINAL PAIN

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I PROPOSE to discuss first the question of pain and the probable paths of pain impulses, in the lower limb, as found in cases of organic disease of arteries, *viz*, arteriosclerosis leading to senile gangrene, and thrombo-angitis obliterans leading to pre-senile gangrene, with particular reference to the operations directed against the sympathetic nerve paths, secondly, to consider the possibility of relieving obscure abdominal pain, untouched by previous abdominal operations of the ordinary kind, by a ramisectomy in the lower dorsal region, as carried out by von Gaza in 1923. I leave aside entirely the efferent or motor side of the sympathetic system, and also the sensory side in its applications to supra-diaphragmatic pain, in particular the forms of angina pectoris.

It may be well to begin with a very brief summary of the anatomy of the sympathetic system, and its connections with the cerebro-spinal system.

The ganglionated cord, as a sort of centre, receives sensory sympathetic fibres direct from the visceral and the vascular plexuses at the periphery. In the case of the vascular plexus, it receives them (a) directly from the main trunks, the femoral and iliac arteries, and (b) indirectly, from the spinal nerves, sciatic, crural, etc., the original sympathetic fibres leaving the arterial walls at various levels to join the spinal nerves, and ultimately leaving the spinal nerves, presumably in the gray rami communicantes, to join it in its lower or lumbar ganglia. On the motor side, it sends out through the gray rami vasoconstrictor, or visceromotor fibres into the spinal nerves adjacent, and also, pretty certainly, directly along the main arteries and to the visceral walls. The visceral sensory and motor fibres probably travel also along vessels, at least in that portion which adjoins the gut. Now, as regards the further course of sensory fibres from the ganglionated cord into the spinal cord, it has been fairly well demonstrated that the majority of these run in the white rami and through the anterior or dorsal roots (Lehmann, Foerster), although probably some still travel through the posterior roots, either relaying or not in the posterior root ganglia.

Their further course in the cord on the road to the higher perceptive centres, chiefly the optic thalamus, is very imperfectly known, but at any rate the path is probably not in the antero-lateral columns, which convey the impulses of pain, heat, and cold, coming up by the cerebro-spinal nerves. These last, by the way, do not all cross, but run up on both sides of the cord. The path of the sympathetic fibres in the extremities is believed to be con-

fined to the two routes mentioned. Sensory nerve endings have been demonstrated by Woollard on the arterial walls. From this point of origin the fibres mostly, after a length of course which is unknown, leave the arteries and join the neighboring spinal nerve, but it is fairly certain that others stick to the artery, and run their whole course along it, right up to some point in the lumbar region where they leave to go direct into the lumbar ganglionated cord. This last assertion, one should add, has been stoutly denied by some, in particular Wiedhopf and Dennig, but in my judgment, the evidence for it afforded by Friedrich and by Abrashonow is too strong to admit doubt. The sympathetic sensory supply to the limbs is undoubtedly dual. Let us now pass to the clinical side.

The earlier operations of Leriche, whose name is rightly associated with the procedure of periarterial, or, as he himself suggests, more correctly, arterial, sympathectomy (inasmuch as it differs essentially from Jaboulay's operation) were designed to influence the nutrition of the limb by means of the marked and lasting hyperæmia, which followed a preliminary spasm of the artery, and this especially for the cure of intractable ulcers. But the accessory observation was soon made that in many cases the pain, which so frequently accompanies conditions of imperfect circulation in the feet and legs, was immediately or very shortly relieved. Leriche considered, and still, I believe, considers, that the relief of pain was due to restoration of sufficient circulation. Consequently, the operation of periarterial sympathectomy was quickly and widely adopted for the type of case which we are discussing, namely, the loss of good circulation in the feet in cases of arteriosclerosis and of Buerger's disease, in the hope of killing two birds with one stone, improving the circulation and relieving the pain.

At this point may I be allowed a short digression to discuss the exact cause of the pain in these conditions. Arteries are sensitive. We know it clinically and experimentally. They are sensitive to direct trauma, to inflammation, and it can hardly be doubted that they are sensitive to changes in their own blood supply, that is a lessening of blood supply to their own walls as to neighboring tissues. The essence thereof probably lies in a disturbance of the acid-base equilibrium through imperfect oxidation of the cells constituting the nerve endings (Payr). Clinically, anyone who follows carefully those cases of Buerger's disease and of arteriosclerosis which show in the foot the signs of imperfect circulation must be struck by the parallelism between these signs and the degree of pain. While the circulation is returning in frozen members, and as long as it is imperfect, pain is severe. In a patient of Bruning's in whom a periarterial sympathectomy in the pregangrenous stage had relieved pain, this recurred as the circulation failed further, and was relieved by an injection of the sciatic nerve. And in my own cases the sequence of events has confirmed me in this view.

Nevertheless, this is not all. Circulation may not be improved, and yet pain may be stopped by a sympathectomy, as is shown in the following instance.

EFFECT OF SYMPATHECTOMY UPON PAIN

CASE I—T M, aged seventy-four, admitted to the Royal Victoria Hospital on July 9, 1924. This patient's leg had been amputated at the knee by Dr F A C Scrimger on July 17, for arteriosclerotic gangrene of the left foot. The popliteal vessels were thrombosed. Very soon after the amputation he began to complain of two distinct pains, one was the ordinary pins-and-needles sensation referred to the foot of the amputated leg. This was very little troublesome. The second pain, a new pain, was described as being of intense, burning character, situated in the stump, which came on in violent spasms very frequently, both day and night, to such an extent that before long it was necessary to have recourse to morphia in considerable doses. During Doctor Scrimger's absence this man came under my care. I convinced myself that his pain was genuine and of the greatest severity. It was not relieved by any of the ordinary drugs and even morphia procured only a very relative relief. I could discover no amputation neuroma, although two or three points in the stump were tender on pressure. On August 21 I removed the sheath of the femoral artery in Scarpa's triangle. The vessel was found to be markedly atheromatous and was thrombosed, as no pulsation was present. In this case, therefore, the removal of the sympathetic plexus in the sheath could have no effect on the circulation, at any rate at this point, nor at the popliteal, and any good effect that might result could not be ascribed to an alteration in the circulation but only to an interruption of pain-carrying fibres. Following the operation his pain was relieved and remained relieved during the six months of his stay in hospital. An unhealed area in the stump did not seem to be particularly affected by the operation and the leg did not show the evidence of any improvement in circulation.

In this case one had to conclude that as a result of the amputation some process had been set up whereby the sympathetic nerve ends, presumably in the ligated artery at the knee, were irritated, giving rise to painful spasms. This observation, I may mention in parenthesis, constitutes a point against the theory of Dean Lewis that improvement as regards pain may be set down to improvement of the collateral circulation through the profunda as the result of the operation which he has proposed recently, namely ligation of the femoral artery, in the idea of forcing a more rapid development of the collateral circulation.

So that I conclude that the adventitia does carry nerve fibres along the femoral artery, the interruption of which can at times stop pain.

But the general experience of periarterial sympathectomy in these two types of cases is one of failure to relieve pain more often than of success. To what are we to attribute the failures? In the present state of our knowledge, we cannot go far in the answering of this question. But I may be allowed to point out certain probable explanations.

First—Although we naturally assume that it is the sympathetic fibres that are alone involved, we have not yet proved that the pain may not in some cases originate in and travel by the spinal nerve fibres to the exclusion of the sympathetic.

Second—Admitting that the pain travels by the sympathetic, there are still two paths which may be taken, and the pain impulse may choose the spinal nerve path and ignore the long path along the arterial wall. The connecting twigs between the artery and the spinal nerves are segmentally arranged and are markedly irregular in the sites of juncture, as shown by Kramer and Todd for the arm and by Potts for the leg. So that a periarterial sympathec-

tomy may strike in at a point which does not happen to catch the particular sympathetic fibres concerned. The fibres may go off to the spinal nerve below, or come in to the artery above the usual site of a sympathectomy in the lower part of Scarpa's triangle. The variations are sufficient to explain many failures.

Finally, the persistence of pain is sometimes due apparently to the advance of gangrene, involving new territories and irritating a fresh group of sympathetic nerve endings. This may occur immediately, or only after a period of temporary relief from pain.

Or again the pain in one spot, as in the toe, may persist, while pain in the metatarsal region, or the heel, or the calf, coincidentally present, may disappear. Such a sequence suggests strongly the existence of more than one sensory path, indeed of many paths, and agrees with the conception of an irregular segmental distribution. The task of working out these paths will be a difficult one, but it can perhaps be solved by a much more thorough clinical investigation and history, along the lines laid down by Sir James Mackenzie, than has been the custom in the past, perhaps also experimentally with the help of Adrian's method of recording pain sensations in animals. However this may be (we come back to the practical problem) in view of the fact that in well over half the cases a periarterial sympathectomy fails to relieve pain. We must ask ourselves whether or not, it is worth while to do that operation at all? In cases in which gangrene is not present but only threatening, it is obviously worth while, because in some the circulation may still be improved, pain relieved, and gangrene staved off (as in three of my series of ten). But when gangrene is already present, why do it? If gangrene persists the patient must come to amputation, and that usually relieves pain with certainty. Why not, therefore, amputate and be done with it? The answer, I take it, is that nobody wants his leg amputated as long as he can avoid it. If the gangrene is limited to part of one or more toes, and is dry, the patient is far more concerned over his pain than over his black toe. Relieve him of his pain, and he will disregard the toe, and may even go about his business and allow nature to amputate the toe when it will. As a matter of fact, the element of pain dominates the situation much more than does the gangrene, which is so often over long periods of time quite limited in extent. Moreover, time that is free of suffering is time gained,—a precious interval during which collateral circulation may gradually develop, and either render amputation unnecessary, or allow amputation at a low level. Many amputations in Buerger's disease have been done at the knee, because of the patient's refusal to endure any longer his agony. My attitude therefore is that any minor surgical procedure, such as periarterial sympathectomy, which can offer a reasonable chance of relieving pain, deserves a trial in all cases of limited and stationary gangrene. But when this operation fails to relieve pain what is one then to do? In the past, amputation at the knee has been very frequently done, since it nearly always cures both pain and gangrene. And in the case of arteriosclerotic gangrene in elderly patients, where the onset of

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gangrene is so often due to a final blocking of the popliteal artery, and it is consequently a hopeless task to try and save the lower leg, I believe that is ordinarily the best policy. But with Buerger's disease, the problem is different. The patient is younger and needs his leg and foot "for his business", the site of the circulatory block and its *modus operandi* are different, allowing a much greater chance for the slow development of collateral circulation, so that, if pain can be relieved, the patient may be tided over the critical period and ultimately lose no more than a toe or two. The chances for a Leriche phenomenon with its hyperæmia, at least in the earlier stages before actual gangrene has occurred or when it is but of slight degree, are better than in arteriosclerotic gangrene. So that the operation, in my judgment, is here entirely recommendable.

But if it fails, it is obvious what one may or must do. One must attack the other route of sympathetic fibres in the spinal nerves. Inasmuch as the pain arises in the district of the terminal distribution of the sciatic, we can do something to the sciatic. To cut it is to paralyze the leg permanently, and therefore not advisable. But a temporary paralysis, which means usually not much more than a foot-drop, may be accepted. Lewis and Gatewood cured 5 cases of causalgia by injecting 60 per cent alcohol into the sciatic. I have one patient who has been relieved in this way, and his report is interesting.

CASE II—His age was thirty. For five months he had suffered severe pain in the left big toe, in the metatarsal region, and in the calf. There was a small indolent infected ulcer at the base of the nail, and the usual dull red discoloration at the base of the toe. No pulsation could be felt in the arteries of the foot, nor in the femoral. On January 16, 1928, a periarterial sympathectomy was done by Doctor Miller of my service. The femoral was found solid. One inch was excised, and the sheath removed over a length of 2 inches. The lumen was filled with a half organized clot. His pain was not modified. Inasmuch as Bazy has reported pain relief following a second sympathectomy extending up beyond the profunda, in three patients who were not relieved by a first sympathectomy done in the usual situation low in Scarpa's triangle, I reopened the wound on February 23, and removed the adventitia above the former site, clearing the femoral up to Poupart's ligament and also the profunda for half an inch. The femoral was blocked and I excised $1\frac{1}{2}$ inches of it below the profunda, the latter artery was patent. There followed permanent relief from the pain in the calf, but none from that in the toe. On February 27, Doctor Miller injected the sciatic with 5 c.c. novocain, without exposing the nerve. There followed relief from all pain for four hours. On March 10, the sciatic was exposed, and injected with 6 c.c. of 15 per cent alcohol. Pain was relieved only in part, and only for some eight hours. On March 22 the big toe was amputated, without relief. Finally, on April 16, the sciatic was again exposed, and injected with 10 c.c. of 60 per cent alcohol. The result was that all pain disappeared for twenty-four hours. Then it recurred in the dorsum of the foot, but not in the toe. Yet it was relatively slight in degree. Morphia became unnecessary, and he was able to sleep, recovered cheerfulness, the result indeed was very much worth while. There was foot-drop, and a patchy anæsthesia in the thigh and leg. The wound at the base of the toe remained unhealed.

Of ten patients treated in the Royal Victoria Hospital in the last four years (of whom seven in my service, two in Doctor Keenan's, and one in Sir Henry Gray's) by periarterial sympathectomy, here considered in respect

of the relief of pain, seven were of the Buerger type, and three of the arteriosclerotic type. Of the seven, two were cured of the pain and also of ulceration and slight gangrene of the big toe, the cures dating from two and half years to six months ago. One was improved greatly, he had no ulceration. Four were failures. Of these three came shortly to amputation at the knee for advancing gangrene, pain not having been relieved, or as in one case, relieved only for a few days. The fourth was the one whose history is related above, whose pain was finally relieved by alcohol injection of the sciatic. The ultimate result in this last is yet to be seen.

In three of the seven the Leriche phenomenon of constriction was seen, but it was not followed by dilatation of the peripheral vessels, yet one of these went on to cure of the ulcer and relief of pain. The other two came to amputation. All cases amputated have been relieved of pain. Of the three arteriosclerotic cases, of which one was also diabetic, the history of the first has already been related. Violent pain arising in the stump after amputation at the knee, was cured by a femoral sympathectomy. In the second, the diabetic case, a popliteal sympathectomy was tried. Part of the big toe was gangrenous. Pain was not relieved and after a week, amputation at the knee was done. In the third case, there was only threatening gangrene of the big toe, but the pain was excruciating. It was nearly always initiated by a coarse jerky trembling of the leg below the knee. The femoral, popliteal, and the two foot arteries could all be felt pulsating. A sympathectomy was first done on the posterior tibial and the dorsalis pedis, both of which were found atheromatous. There resulted no relief from pain, nor any improvement in the circulation. Five days later, the femoral adventitia was removed. The artery looked normal. No Leriche phenomenon was observed at either operation. For two days he was somewhat relieved, the vise-like quality of the pain was much less. But after four days he was suffering as much as ever. He insisted on going out, and would not accept an injection of the sciatic.

In three of the cases, the anterior crural nerve was injected with novocaine at the time of the sympathectomy, but without relief. The sciatic nerve would appear to be the only one concerned in pain arising in the foot.

It remains to mention the possibility of attacking the sympathetic higher up than the femoral artery. Upon a priori grounds, if the pain is of sympathetic origin, and if all sympathetic fibres, whether in the limb they travel along the arterial wall or in the spinal nerves, still meet at a common junction in the lumbar ganglionated cord, an attack upon this common meeting place ought to catch all sympathetic pain impulses from the lower extremity, and might be expected to relieve pain regularly. And as a matter of fact Brown reports from Adson's service in the Mayo Clinic five cases of thrombo-angitis obliterans operated on by a bilateral lumbar sympathetic ganglionectomy with perivascular neurectomy of the common iliac arteries. In all there were "trophic ulcers" and pain was excessive. "Relief from pain was complete in all the patients and has persisted to date," (periods of three to seven

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months) Brown and Adson, however, do not recommend the operation for cases of senile arteriosclerosis on account of the increased risk in these usually feeble patients

Such uniformly favorable results have been obtained by no other procedure. Although the series is small, it is significant. It speaks strongly in favor of the theory that the pain of circulatory anemia originates in sympathetic end receptors, and that it travels along sympathetic paths. Yet it may well be asked whether so extensive a removal of the lumbar sympathetic is necessary. I imagine that our efforts henceforth should be directed toward the rami communicantes, on either side of the sympathetic ganglia, where also the sympathetic supply is crowded into a narrow path. In the meantime, I conceive that the order of operation should be, first a femoral sympathectomy, or possibly, as our knowledge increases a sympathectomy over a site on the main artery chosen according to the situation and character of the pain. Next, if that fails, an injection of the sciatic nerve with 60 per cent alcohol or 5 per cent formalin (which Foerster recommends), accepting the temporary foot-drop, and finally, if necessary, a last attempt of the nature of Adson's operation, or possibly a simple lumbar ramisection. All these procedures are directed solely towards the relief of pain during the stage at which the malady is uncomplicated by gangrene or the gangrene is very limited, dry and non-progressive. It is recognized that an amputation at the knee will practically always relieve pain, and represents a last resort after these smaller operations have failed.

I pass now to a consideration of the relief of chronic abdominal pain through cutting of the rami communicantes which connect the ganglionated cord with the spinal nerves and also with the spinal cord itself. Whatever one may think of the sympathetic supply to striated muscle and the sympathetic control of postural tone, and of the Hunter-Royle operation, one can have no doubt of the existence of sensory visceral fibres, and of their reaching the spinal cord through the rami communicantes.

According to André Thomas, the white rami contain pre-ganglionic fibres coming from the sympathetic column and ending in the spinal ganglia or in the cord, as well as also other elements of sensory nature and of various origins. The gray rami are composed of post-ganglionic fibres which originate in the ganglia and end in the periphery, after running in the spinal nerves and along the vessels. The outstanding example of a surgical attack designed to relieve pain through interference with pain paths running from the sympathetic ganglia to a peripheral distribution in visceral organs, is found in the operations on the cervical sympathetic ganglia, for the relief of the pain of angina pectoris. With this part of the subject I have nothing to do at the present time, but I would like to call your attention to another application of the same principle, concerned this time with the relief of chronic abdominal pain.

Von Gaza, in 1923, published an article which has been too little recognized. Von Gaza was greatly interested in that class of patient with whom

we are all only too familiar, in whom chronic abdominal pain brings the patient to the operating table time after time for various abdominal operations, each one of which in turn fails to afford relief. He was convinced that many of these patients show the stigmata of a general psychic and vasomotor irritability. For instance one sees in them dermographia or wheal formation upon slight skin irritation. This is clearly an effect of irritability in the musculature of the superficial blood-vessels. He argues that the same condition may be present in the involuntary muscle of the abdominal organs, or perhaps in the vessels supplying those organs. Thus, in the stomach, such patients are apt to suffer from hypersecretion and hypermotility, and sometimes from erosions of the mucosa and petechial hæmorrhages. In the bowel it is called mucous colitis. They are often the victims of repeated futile abdominal operations at which no explanation of the pain can be found in organic changes. In succession the appendix is removed, or an ovary resected, then the gall-bladder excised, and finally, perhaps, a colopexy is done in order to support a supposedly mobile cæcum. Usually the pain recurs after each operation, except in a few instances, in which, as von Gaza believes, the sympathetic fibres supplying these organs may well have been stripped and torn, thus incidentally interrupting the sensory path through this system of nerves. The condition he considers as one of intra-abdominal vasomotor and enteromotor neurosis, in which segments of the vegetative nervous system, and especially the segments to which the afferent and efferent paths running in the rami communicantes belong, are in a condition of neurotic dysfunction. The condition he thinks is one of "irritative weakness" of the vegetative nervous system, and often due to psychic trauma, and he found it apt to occur in people of asthenic type or in the adipose. Whether the pain was due to neurotic cramp of vessels or of muscles, he thought it impossible to determine.

Upon the basis of this theory it seemed obvious that one might be justified in an attempt to interrupt directly the path of such pain impulses by cutting the rami communicantes through which the afferent or sensory nerves of the sympathetic had to run in order to reach the cord and thence reach the ultimate pain perceiving station in the brain.

It was, however, clearly important to make an exact topical diagnosis of the pain and of the ramus through which such pain impulses passed, and von Gaza in this respect acted upon the knowledge afforded by Kappis and Lawen. Kappis, by means of section of the cord at various levels, and Lawen, by means of paravertebral anæsthesia with novocaine, had been able to fix approximately the levels of the segmental sympathetic innervation of the viscera. The practical method was that of Lawen, which consisted in an injection of 10 c cm of 2 per cent novocaine into the intercostal nerves just outside the lateral vertebral foramina, at various levels, the novocaine diffusing through into the rami and posterior root ganglia, so that the pain of a gall-bladder inflammation, or of a kidney lesion, or of a stomach lesion according to the segmental level, might be relieved in this way for a few

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hours Von Gaza's procedure, therefore, in some fifteen cases of the type described, was to inject paravertebrally at appropriate intervals of time the intercostal nerves from the eighth dorsal down to the twelfth, and see at which level the abdominal pain was abolished. At times one or two injections would apparently relieve the patient for prolonged periods, in one case permanently. Having thus made a topical diagnosis of the segmental level of the pain, he proceeded in one case to cut the *rami communicantes* at the level of the tenth dorsal, removing at the same time the posterior root ganglion. This was followed by a permanent cure.

Von Gaza does not seem to have found imitators, for I can find no record of similar operations having been performed in the intervening period, yet I feel that there is something very promising in this procedure, if one can select the cases aright. Doctor Scrimger, assistant surgeon to the Royal Victoria Hospital in Montreal, and adjunct surgeon in my service, called my attention to von Gaza's article, and was the first, so far as I know, to repeat von Gaza's operation. This was in the fall of 1926. Since then we have each operated on another case, three in all. He will shortly publish a detailed report, but meanwhile, with his permission, I may give you a short account. Technically, the operation is not difficult. Through a laminectomy incision, one shoves back the muscles on the side affected, chisels through the transverse processes, and removes these by blunt and sharp dissection, whereupon the intercostal nerve is easily exposed, after cutting through the intercostal muscles, at its entrance in the intercostal space. The nerve is hooked up, and there then appear, dragged up with the nerve, the *rami* concerned, usually two in number, fine twigs, but discernible without difficulty. These are cut across or evulsed at their junction with the spinal nerve. The wound is then closed as usual. One danger is that of tearing or cutting the pleura. In the patient that I operated on, this accident occurred through my thoughtlessly using a sharp knife for dissecting out the transverse process. I plugged the opening with a muscle graft, but some pneumothorax persisted and some effusion appeared in the pleural cavity. This seemed in the next ten days of no consequence, but on the tenth day as she was straining at stool, sitting up in bed, she became suddenly dyspnoëic, intensely cyanotic, and died in fifteen minutes. The pathologist diagnosed bilateral pneumothorax and death from asphyxiation, as the lungs were collapsed and showed, with other organs, the usual signs of asphyxiation. I can myself give no other explanation, although no hole could be found in the mediastinum to explain the sudden irruption of air from one pleural cavity into the other. I am glad to say that Doctor Scrimger's two cases came through perfectly.

I may now report these three histories very briefly. The first, Miss F, aged twenty-eight, operated on in the summer of 1926, by Doctor Scrimger, had suffered for several years from chronic left-sided abdominal pain, localized chiefly in the distribution of the eleventh and twelfth dorsal segments. She had had several operations, the left ovary had been removed for a cyst, the appendix also. An exploratory operation, ending as such, had been done. Finally, she was suspected of a left pyelitis, though examination did not confirm this sufficiently, so that she escaped a nephropexy or a nephrectomy.

None of these measures relieved her pain. She was generally regarded as a trying neurasthenic. Finally she came under the care of Doctor Scrimger in my service, who after establishing her segmental level of pain by Lawen's method, cut the rami of the eleventh and twelfth dorsal nerves, since when she has been entirely relieved, and extraordinarily grateful.

The second case was the unfortunate one operated on by myself. She had begun to suffer from right-sided abdominal pain in the lower quadrant in 1923, accompanied by constipation and nausea, and by frequency of urination. In April, 1925, she had been operated on under the diagnosis of chronic appendicitis. The appendix was removed and an extensive colectomy done. The pain was unrelieved. At this operation, all the organs were found normal, except for appendiceal adhesions and a parieto-colic band. In December, she came under my care, and on December 26 I cut the rami of D 10 and 11, opening the pleura as already described. It is worthy of note that Doctor Scrimger's patient after operation passed through a week or ten days of great pain in the back and loin, which I interpret as being due to irritation of the cut central ends of the rami, before relief came. One finds the same thing, moreover, in those cases of femoral sympathectomy which ultimately are relieved. The same was now true of this second patient. But on the tenth day, she sat up in bed, and declared to a neighbor that she believed she was now well of her pain, that she felt better than for years. In the afternoon she died suddenly, as related.

The third patient was operated on in the same way by Doctor Scrimger. Her age was twenty-nine. She was admitted on November 14, 1927. For nearly ten years she had had abdominal pain. In 1919, the appendix and the right ovary had been removed. In 1920, there was a history of some kidney lesion—"the kidney was infected", it was "drained," and "healed up." In 1923, the abdomen was opened for adhesions, and an extensive colectomy was done on the right side. As pain was not relieved, and seemed to be in the distribution of the eleventh and twelfth intercostal nerves, these were resected posteriorly near the angle of the ribs. Pain persisted. Finally, in June, 1927, she was admitted to Doctor Scrimger's service, and he made a preliminary investigation according to Lawen, but postponed operation. The pain then grew constant, prevented sleep, caused vomiting, and for two weeks she refused food, although the pain had no relation to the taking of food. The kidney and gall-bladder were proved normal, the appendix and ovary were out of the way, also the intercostal nerves, the right colon had been lifted and fixed. Remained undoubtedly peritoneal adhesions! Should one repeat the old story and separate adhesions that had been caused only by operations for a pain that was there from the beginning? Doctor Scrimger thought not. He did a ramisection of dorsal eight to eleven. The patient continued to suffer for several days, after which pain left her for good.

Patients of this class have long been set down in the clinical mind as being neurasthenic or psychoneurotic, and one must still admit presumably the correctness of this view for a certain proportion of them. Yet it is clear from these reports that this field is worthy of exploration, and one may anticipate that with augmented experience it will become possible to select cases suitable for the operation, with reasonable accuracy.

We must go back to a deeper study of the anatomy and physiology of the sympathetic system on its sensory or afferent side, and, clinically, to a more exhaustive investigation of the symptom of pain in all its modalities.

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DISCUSSION OF PAPERS RELATING TO THE SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM

DR WALTON MARTIN, New York City, referred to a case reported in his paper which he thought has some bearing on Doctor Crile's paper. A baby, about two months old, was given by mistake a large dose of pituitary extract. A few hours after the administration of the drug a curious spasm of the vessels of the extremities occurred. The feet and the fingers of both hands were involved rather irregularly, turning blue-black before the death of the child. That is, there was a condition of spasm of the vessels produced by administration of the extract of the pituitary gland, such as we are accustomed to think of as associated with the over-activity of the suprarenal gland. It emphasizes the extraordinary difficulty of putting a correct value on the secretions from the internal glands. We know so little about them that it hardly furnishes a sound basis for surgical treatment.

DR ALEXANDER PRIMROSE, Toronto, Canada, said that while discussing the beneficial results of periarterial sympathectomy in certain of these cases of failing circulation in the extremities, one may inquire as to whether or not similar results may be obtained by other means. His experience in a recent case of intermittent claudication leads him to believe that such is true.

Some little time ago the observation was made that the peripheral circulation would be improved by the use of diathermy (*vide* Gill and Moss, *Lancet*, October 29, 1927). Similarly the peripheral circulation is said to have been improved by the use of high voltage X-ray treatment over the region of the conus medullaris of the spinal cord. Improvement in the following case by these methods of treatment was so marked that he desired to put it on record.

W. H. P., age sixty-seven, male, for three years had noticed a progressive weakness, with aching pain in his legs. The distress was at first more noticeable in the right calf than in the left. When first seen by the speaker three years after the onset of his trouble he was able to walk fairly long distances. Thus he played eighteen holes of golf but was compelled to rest at short intervals, complaining of aching pain in the calf of each leg, with numbness and coldness of the feet. A careful analysis of his symptoms and of the local condition led his medical attendant, Dr. Samuel Mirsky, of Ottawa, to conclude that he was suffering from obliterative endarteritis with an arteriosclerotic basis. Pulsation was found in the femoral arteries but none in the popliteal, the posterior tibial or the dorsalis pedis arteries. The toes and feet were of a dusky cyanotic hue, with surface temperature somewhat lower than the rest of the leg. The right toe on its external surface showed a small indolent ulcer, in reality a gangrenous patch, possibly induced by slight trauma.

Eventually this patient suffered so much distress that his sleep was dis-

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turbed. He was kept at rest in hospital and his physician employed water-cooled ultra-violet ray over the ganglionic area. Improvement was noted. The speaker saw him about this time in consultation. On his return to Ottawa, the ultra-violet ray was continued, and in addition, on January 24, 1928 treatment by diathermy was begun along with X-ray therapy over the lumbar spine. The improvement was marked. March 14, 1928, Doctor Mirsky writes "For the past month he has been entirely free from symptoms. There has been no pain in the toe, he has been able to walk distances which before always produced pain in the calves, without any discomfort. The colour and temperature of both extremities is remarkably improved." April 19, 1928, he writes "Mr. P. has been back to his usual duties for a period of one month and during this time he has been continually improving."

The surface temperature is markedly improved and the area where the gangrene originally was is now covered by healthy epithelium."

DR. FRED B. LUND, Boston, Mass., said in regard to the tumors of the chromaffin glands and particularly of the carotid body, which had been discussed by Doctor Reed, that eleven years ago he reported a case of a woman who was operated on at sixteen years of age for a tumor of the left carotid body. Dr. George W. Gay was able to remove this by peeling off the carotid arteries without tying the carotid. At the age of over fifty she had come to the speaker with a tumor on the other side, which proved to be a tumor of the carotid body, which had grown very large and extended around both carotids, so that the removal of the tumor required the ligation of the common carotid and also of the external and internal carotids. No operative accidents occurred and she made a perfect recovery. The mortality of these cases at the time of this operation was very high and it was in fact so discouraging that Doctor Da Costa had advised against operating on such tumors. The high mortality came from anæmia of the brain, resulting from tying of the carotid, and also from injuries to the pneumogastric nerves, which were not infrequently damaged.

After this case Doctor Lund never saw another until this year. In the former case it was easy to make the diagnosis on the pulsation of the tumor communicated from the carotid artery and the fact that she had had a similar tumor removed on the other side. As the second operation required the ligation of the carotid on the right side, it is evidently fortunate that Doctor Gay was able to remove the tumor on the left side without ligating the vessels. This winter a second case appeared in a man of fifty, who had an abscess in his left tonsil and a small tumor under the angle of the jaw, which felt like an enlarged lymphatic gland. No pulsation was noticed in the tumor. The tonsil was removed and the tumor remained unaffected. The tumor felt lobulated and soft, in fact felt very much like a submaxillary gland. He did not make the diagnosis of a carotid body, cut down on it and found that the submaxillary gland was pushed upward and lay in front of a round, solid tumor surrounded by a tremendous plexus of veins. After tying a

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large number of veins and clearing the outside of the tumor and lifting it up, the bifurcation of the carotid was lifted right outside the wound with it. It was possible to perfectly peel the tumor off the carotids, common, external and internal, without ligating any of those vessels. There was an injury to one of the lower branches of the facial nerve, which caused a slight droop of the lip for a short time, but this entirely recovered. It was probably a branch of the nerve which was caught in a ligature. The pathologist's report showed an intercarotid body.

DR LEONARD FREEMAN, Denver, Col., said that some twenty-five years ago, shortly after Jonnesco's original communications on the subject, he did thirty-four cervical sympathectomies on eighteen patients. Sixteen of these were epileptics and two were suffering from glaucoma.

In the sixteen epileptics, the operations were done by removing the superior and the middle ganglia when the latter was present. The results were not sufficiently good for him to continue the operation, and since that time he had not done it. Of the cases operated upon one seemed to recover permanently, at least he was well five or six years afterward when he was lost sight of. One case was improved for a number of years. The remainder of the cases had no perceptible improvement.

In the glaucoma cases, one recovered permanently and is well at this time, at the end of twenty-five years. In the other one there was no influence upon the glaucoma.

In regard to the statement of Doctor Archibald that continuous fibres of the vegetative system run along the larger arteries, Doctor Freeman remarked that in 1923 a very suggestive experiment, which seems to support this, was made by Salomon and Schwartz in France. A man had gangrene of the great toe that was extremely painful. A periarterial sympathectomy was done under spinal anaesthesia. The somatic nervous system was completely paralyzed, no sensation being felt in the lower extremities, and yet when the nerve plexus surrounding the femoral artery was pinched with forceps, the man complained of violent pain in the region of the gangrene in his toe.

DR FRANK S. MATHEWS, New York City, remarked that it seems quite definitely proven that the adrenal bodies are necessary to life, and that the part that secretes the active hormone, adrenalin, is the medulla. This part, however, is not essential as has been shown by experiment. At this we are not surprised because there are other masses of chromaffin tissue in the thorax and abdomen which may well supply the deficiency. When one adrenal is removed there is no special result—another illustration of the "factor of safety" in body organs. Two weeks later a half of the remaining gland may be removed without causing death of the animal. The animal has then been deprived of three-fourths of its adrenal cortex. The function of the cortex is admittedly obscure. Marine has removed three-fourths of the cortex and a little more—what he calls a sublethal reduction of the gland. In his animals there resulted a hypermetabolism. This is perhaps the nearest

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we have come to seeing a hyperthyroidism produced in animals. No clinical exophthalmic goitre has been observed in animals, though in the thyroid gland of dogs have been seen the changes which would seem quite characteristic of exophthalmic goitre if seen in man. So far, then, as we have intimations of the function of the cortex, it acts to inhibit the thyroid and it does not seem that an operation which curtails the activity of the adrenal would be of value in exophthalmic goitre. The only other experimental work except Marine's which produced a condition resembling exophthalmic goitre is the work of Cannon in which he anastomosed the phrenic and cervical sympathetic. In his animals (cats) changes in the adrenals were noted. No subsequent work has been done by either Cannon or others along these lines. With our present knowledge it would seem more reasonable to think that the adrenal cortex has an inhibiting action and not a stimulating one on the thyroid, and hence that it is not desirable to lessen the amount of the cortex in exophthalmic goitre. An observation of some interest is that the adrenal is large in late foetal life at a time when the thyroid activity (heat production) is in abeyance. At birth the thyroid must begin to function and the need for inhibition through the adrenal would be less.

Doctor Archibald speaks of pain in the sympathetic nervous system. It has always seemed to the speaker unfortunate that the word "sympathetic" was ever applied to that system, because it immediately suggests sensation or reflex action, whereas the physiologists usually describe the system as an efferent one. It seemed to him that it simplifies and gives an accuracy to our thinking if we consider that system as an entirely efferent one, being a means of distributing impulses that come from the spinal cord and then pass to various organs and blood vessels. Apparently there is no reflex action produced without the mediation of the cerebrospinal system. If a blood vessel is pinched, we feel pain as Doctor Archibald has shown, hence a nerve fibre carrying pain sensation must run in the wall of the vessel and for a distance at least passes with the sympathetic nerve fibres. If these fibres, however, are traced back, they pass through the sympathetic ganglia and find their nerve cell in the posterior root ganglia or in the cord and hence are more properly spoken of as belonging to the cerebrospinal system rather than to the sympathetic one. On this point of view the question of whether a nerve fibre is sympathetic or cerebrospinal is decided not on the basis of what fibres it accompanies on its way to the periphery but whether its trophic centre is located in the chain of sympathetic ganglia or whether it is located in the cerebrospinal axis. If this distinction is adopted, the so-called sympathetic or autonomic system becomes a more definite anatomical and physiological unit, being efferent in character and physiologically confined to bearing impulses over a comparatively few nerve fibres from the cerebrospinal system to the chain of ganglia which then diffuse the impulses over a large physiological distribution.

Doctor Archibald no doubt meant that these efferent impulses travel largely with sympathetic or autonomic fibres and hence he includes them with

DISCUSSION

the system. It will clarify our thinking of the autonomic system if we consider it not directly concerned with pain.

DOCTOR ARCHIBALD (in closing) said that the observation related by Doctor Freeman meant that his spinal anæsthesia did not reach so high as to block the entrance of the sympathetic fibres which came in above that point. Surgeons have increased their knowledge gradually concerning the paths of the sympathetic, for instance, we now think that the sympathetic nerves run with, or carry the fibres of deep sensibility, and that these are extremely apt to run up in the ganglionated cord and to pass into the spinal cord at a higher level than the segmental level which receives the posterior root fibre of the cerebrospinal nerves coming from the corresponding region of the periphery.

For instance, it has been said that the return of bladder function after a transverse myelitis or transverse lesion of the cord may be very possibly due to the ascent of bladder fibres in the ganglionated chain and their entrance more or less high in the thoracic region and above the level of the lesion.

Doctor Archibald said that the closing part of his paper essentially consisted in the relation, very briefly, of three cases of the operation of Von Gaza. Von Gaza, in 1923, viewing the *rami communicantes* as the best point of attack to relieve pain considered as coming from the abdominal sympathetic system, conceived the idea that these cases of chronic abdominal pain, in which pain recurs after a series of futile operations in the abdomen, might be relieved by a section of the *rami communicantes* if one could ascertain the exact level at which these pain fibres enter the cord. That knowledge of the segmental level localization is furnished by the work of Kappis and of Lawen. They were able to establish the fact that the site of the pain as described by the patient corresponded to certain segmental levels, say of dorsal eight and nine, dorsal nine and ten, and so on. For instance, the pain of a gall-bladder lesion might be really due to a state of hyperexcitability in the sympathetic system at a segmental level corresponding, let us say, to dorsal eight and nine, so that when a paravertebral anæsthesia was done, blocking the eighth and ninth intercostal nerves just outside the transverse processes and infiltrating the *rami communicantes* which join these nerves at that point, pain would often disappear. On the other hand it was found that the injection of the intercostal nerves in their course distal to that point would fail to relieve the pain. Doctor Scrimger, assistant surgeon at the Royal Victoria Hospital, after reading the article of Von Gaza's, operated on one case in 1926, securing for the patient complete relief. He drew my attention to the subject and I operated on a second patient who likewise got relief but unfortunately died on the tenth day post-operatively from a double bilateral pneumothorax. And finally Doctor Scrimger operated on another patient last November with complete relief, the relief having lasted now in one case six months and in the other two years and a half. I wish to call the attention of the members to this particular experience, in case some were unacquainted

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with the subject, and to emphasize the fact that for these chronic sufferers, so often bandied about as neurasthenics from clinic to clinic, there is still hope through ramiectomy, provided the cases are well chosen, and that they do not need to be referred continually back to the neurologist and the internist

DR WALTON MARTIN (in closing) said that he thought the most important contribution made to-day was in the paper of Doctor Adson and Doctor Judd. This contribution seems to him a real one, and in the rather hazy reports of the results one gets of various operations on the sympathetic system it stands out. The evidence furnished of the benefit gained by a division of a portion of the sympathetic system in the curious condition of congenital megalocolon seems convincing.

In regard to the relief of pain, the boy who has lost his foot has not gone on with any symptoms that would suggest that he is now having anything like a spasm of the vessels, and has had no recurring attacks of pain.

TUMORS OF THE AUTONOMIC NERVOUS SYSTEM

BY MONT R. REID, M.D.

OF CINCINNATI, OHIO

THE accidental finding during the past year, in two cases of chronic appendicitis, of what appears microscopically to be carcinomatous growths of the appendix, and the rather recent conception that such tumors have

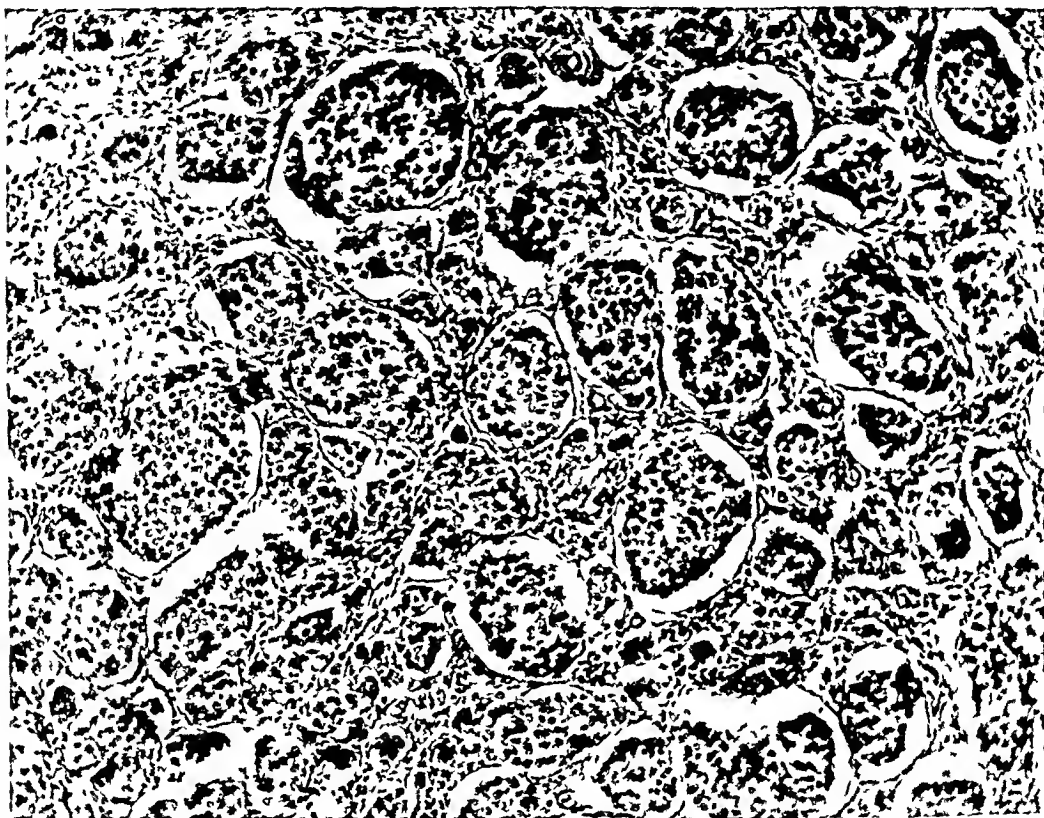


FIG. 1.—“Carcinoid” tumor of the appendix. Low power magnification. Note the similarity to Figure 8

their origin in the chromaffin tissue of the autonomic nervous system, have led me to present to this Society a brief report on the tumors of this nervous system

On August 5, 1927, Doctor Zinninger, our Resident Surgeon, operated upon a white woman, aged thirty years, for cholelithiasis associated with an hydrops of the gall-bladder. Before performing the cholecystectomy he removed the appendix because “it was bound down by adhesions and its tip obliterated.” The external appearance of the appendix resulted in the operator’s usual diagnosis of chronic appendicitis. Our pathologist, Doctor Conway, reported on the histological study of the appendix as follows: “The section from the distal portion of the appendix shows the muscular and outer coats to be apparently normal. The mucosa, however, presents a picture which is entirely unusual. The entire lumen is filled with a mass of epithelial cells. These cells are grouped in small areas irregularly placed and resting upon a dense fibrous tissue framework. The

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cells appear to be of epithelial origin, containing large darkly stained nuclei and a moderate amount of lightly stained cytoplasm. The cells are closely packed and their nuclei are generally uniform in shape and size. There is no infiltration of the outer coats of the appendix by this growth. It is limited entirely to the mucosa of the appendix." The pathologist's comment was that the growth resembled an adenoma. The histological appearance of this tumor, the ability of the cells to take up a silver stain and its resemblance to the 325 previously reported cases leave no doubt that it belongs to the group of "carcinoid" or "argentifine" tumors, or paragangliomata of the appendix.

The second case was a young girl, aged twenty-two years, who was operated upon by me on March 10, 1928. Six days previously she developed, for the first time, the

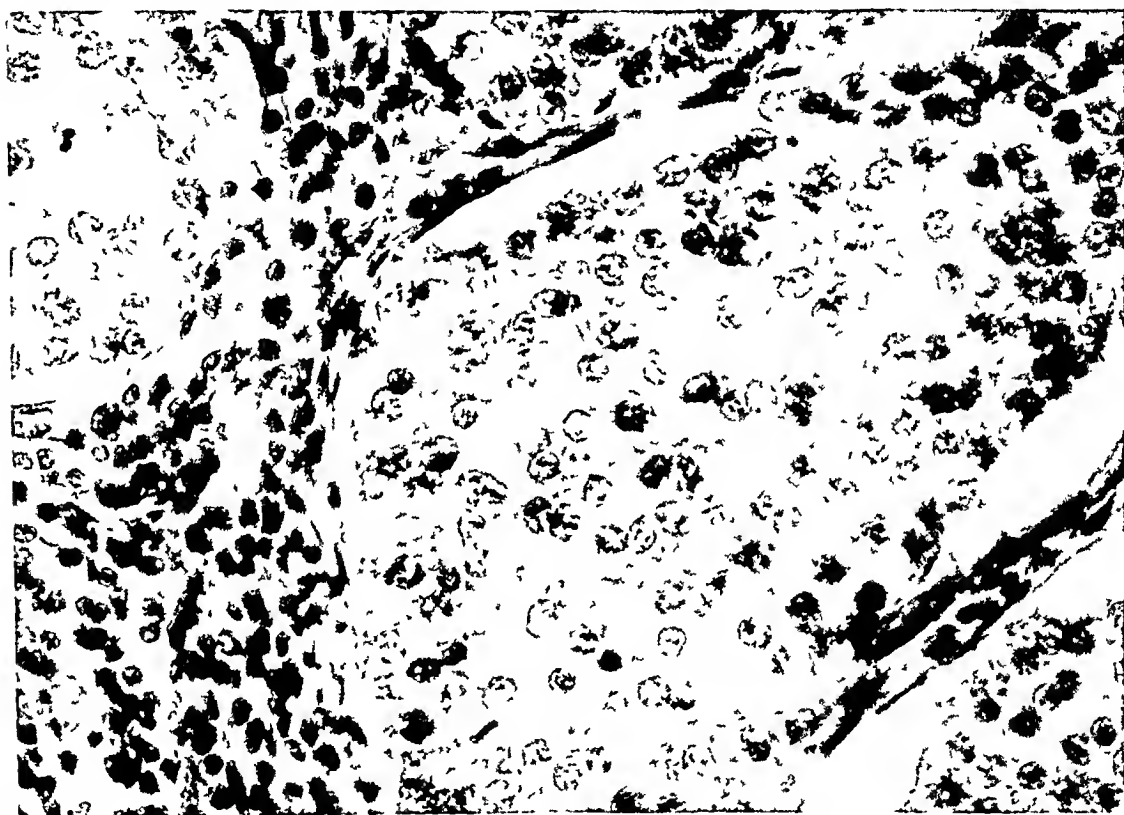


FIG. 2.—High power magnification of a paraganglioma of the appendix. Same case as shown in Figure 1.

typical symptoms and signs of an attack of acute appendicitis. When she came under my observation twenty-eight hours later, it was evident that the attack was rapidly subsiding. Five days later the re-occurrence of slight local pain and tenderness caused us to operate. To our surprise the distal third of the appendix contained a yellowish necrotic-appearing segment about one-half centimetre in length, which apparently was covered by a very thin layer of fibrin. The rest of the appendix seemed to be normal and there was no zone of acute inflammation about this segment. There were no adhesions. On opening the appendix the involved segment presented a yellowish-white surface which was rather tough. It resembled tuberculous tissue but was uniform in color and was obviously not necrotic tissue. Microscopically the growth is a typical "carcinoid" tumor of the appendix. The cells reduce silver from an ammoniacal solution. In this instance the growth involved the entire thickness of the appendiceal wall.

The color of the growth in this case was almost identical with the medulla of the suprarenal gland and was strikingly like that observed in a few cases of carotid body tumors that I have removed.

In considering the neoplasms of the autonomic nervous system, the embryological development of this system must be borne in mind. Through

the cells composing the primitive neural tube, the so-called neurocyte, the autonomic system is related to the somatic nervous system. Certain undifferentiated cells called neuroblasts migrate ventrally from the neural tube giving origin to the sympathetic ganglia and to the chromaffin tissue. This in the human is located for the most part in the medulla of the suprarenal but is found in the so-called carotid, aortic, cardiac, tympanic and coccygeal glands, and in the gelben zellen of the Crypts of Lieberkuhn in the gastrointestinal tract.

Tumors of the autonomic nervous system may be conveniently classified as Neurocytoma, neuroblastoma, ganglioneuroma, paraganglioma, neuroma.

From the neural epithelium arises the *neurocytoma*, a single case of which,

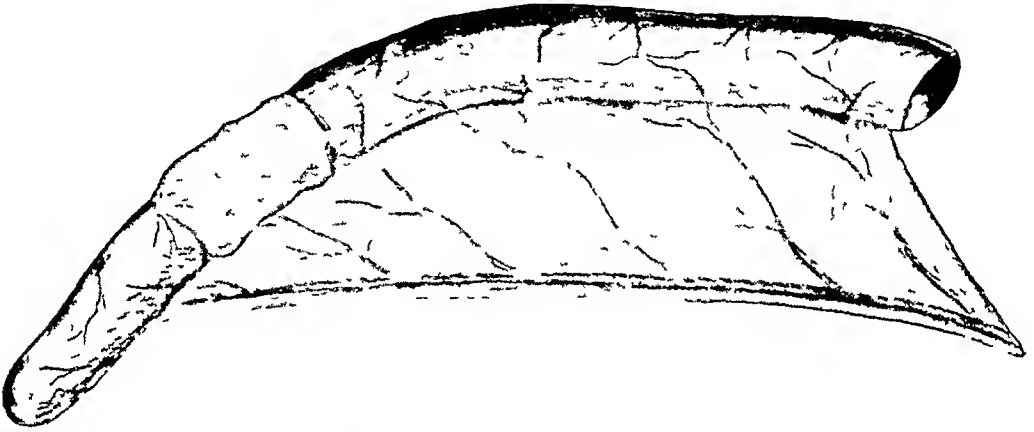


FIG 3—"Carcinoid" tumor (paraganglioma) of the appendix. The color of the lesion was yellowish

arising in the neighborhood of the gasserian ganglion, was reported by Marchand. The neuroblasts, however, give rise to neoplasms more frequently.

Neuroblastoma is the name most commonly applied to the malignant tumor that apparently arises from the neuroblasts or undifferentiated cells from which the autonomic and chromaffin systems develop. Other terms are Ganglioma embryonale sympathicum (Pick). Sympathicoblastoma (Pick and Bielschowsky, Bailey). Sympathigomon (Herxheimer).

This neoplasm occurs predominantly in infancy or early childhood, several having been congenital. Twenty-five, or 80 per cent of the patients, were less than two and one-half years old, but three cases (Ritter and Meltzer) have recently been reported in patients over forty years of age.

The site of predilection is in the suprarenal gland, as shown by the fact that in twenty-seven of the cases the primary growth was found within this organ. In one case, both suprarenals were involved. In the remaining cases, the primary sites were in the sympathetic chain, the coccygeal gland, the uterus, upper jejunum and the nasal cavity.

The primary growth in neuroblastoma is usually quite small, though occasionally it may become very large. From very small, primary tumors (8 mm diameter in one case) metastases in the liver, lungs, lymph glands, etc., may occur and reach a considerable size. The smaller tumors may be confined to

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the medulla and thus present simply as an enlargement of the suprarenal gland. The larger tumors and metastases are nodular masses of rather firm consistency. Gross section shows them to be surrounded by a thin layer of fibrous tissue and to contain numerous thin-walled vessels. The cut surface is glistening white in color and soft in consistency and from it a pearly juice can be expressed. Intermingled with the glairy white tumor tissue are a variety of colors—orange, red and black, such as are often seen in xanthoma—which are due to hemorrhage, the blood pigment being in various stages

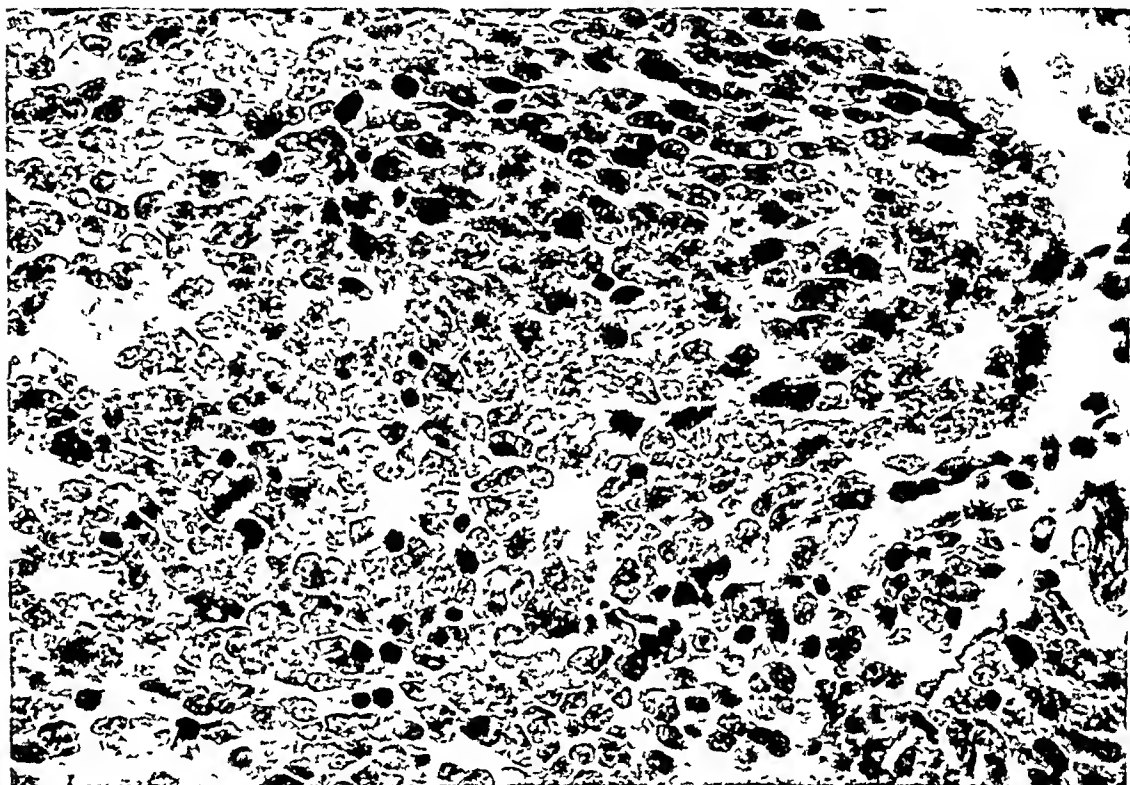


FIG. 4.—Histological appearance of a neuroblastoma

of degeneration. In the larger nodules central necrosis occurs, giving rise to cavities filled with clear or brownish fluid.

Microscopically the tumors are alveolar in topography, the septa consisting of delicate connective tissue and thin-walled blood-vessels. The cytology of the tumor cells is somewhat variable, all stages of cells from neuroblasts proper to more mature and even differentiated ganglion cells being found in certain tumors. The predominant cells in the pure neuroblastoma are small, being little larger than the lymphocytes, and contain a relatively large, deeply chromatic nucleus with but a minute amount of protoplasm. In the most typical growths, certain of these cells are arranged in rings surrounding a central mass of fibres, the so-called "rosette" formation, a structure particularly characteristic of this type of neoplasm.

The cytology seems to vary with the rapidity of progress of the growth and the age of the host. Thus the more rapidly growing tumors occurring in the new-born or very young infants, are made up almost entirely of the

small neuroblast type of cell, while in older patients or less malignant growths, mature ganglion cells with fibril formation may be seen (Landau) Indeed, neuroblastomata and ganglioneuromata may occur in juxtaposition or may be intermingled in the same tumor These fibrils have been thought to be nerve fibres, but their failure to stain with silver tannate by appropriate methods argues against this point of view

Metastases from the primary growth extend first to the neighboring lymph-nodes, and thence to the liver, bony thorax and bones of the calvarium

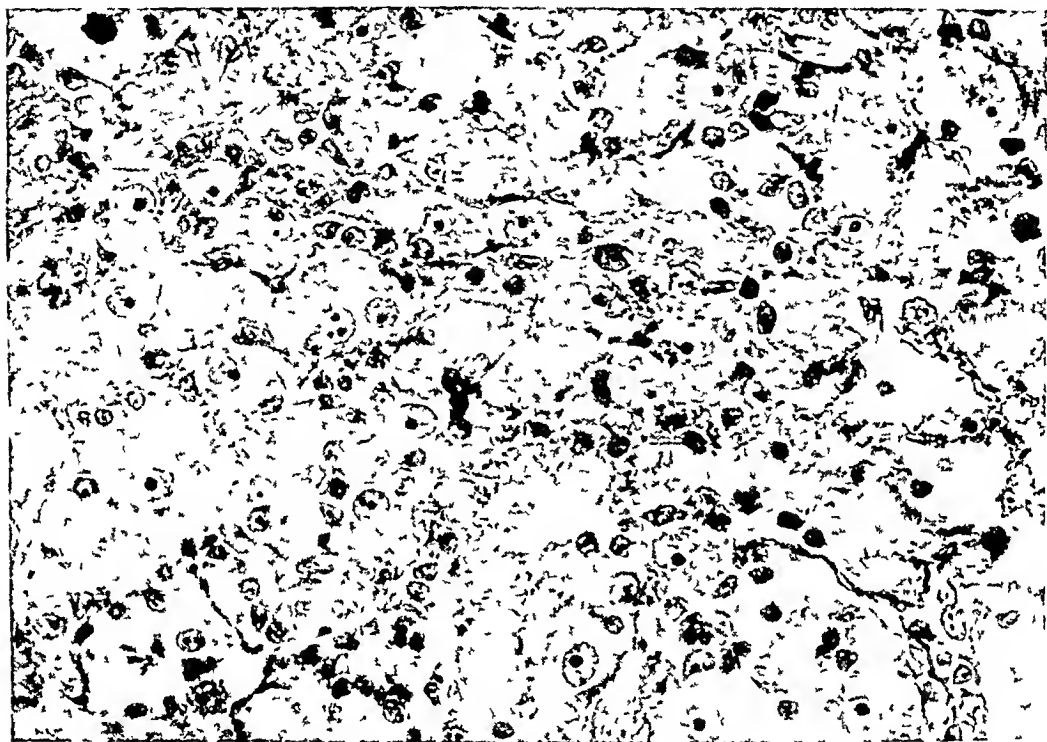


FIG 5 —Histological appearance of a ganglioneuroma Note the large ganglion cells

and orbit, the spread being apparently by the lymphatic channels But the widespread liver and lung metastases such as are seen following dissemination by way of the blood stream also occur

In a small percentage of the cases the presence of a tumor in the supra-renal medulla is heralded by the symptoms of Addison's disease, notably asthenia and cutaneous pigmentation However, in the larger proportion of the cases the growth has given little evidence of its presence until widespread metastases have produced pressure effects either in the abdomen or intra-cranial contents

Two clinical types have been differentiated, the one which because of intra-cranial or retro-orbital metastases, presents with exophthalmos, epileptiform seizures or paralyzes, and a second group, in which progressive enlargement of the abdomen is the first symptom

The primary diagnosis of neuroblastoma in the absence of a biopsy is almost impossible, but this growth should be suspected, particularly in young

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children, when a mass is found in the region of the suprarenal gland with characteristic metastases, or the liver is markedly enlarged without marked ascites. The presence of Addison's syndrome would be of definite aid in the early diagnosis but this unfortunately is present in but a small number of the cases.

The prognosis in these cases is distinctly bad, only one patient, reported by Lehman in 1917, having been successfully operated upon. In that instance, the tumor was confined to the suprarenal gland, which had become enlarged and pedunculated and could thus be completely excised.

In all but a few of the reported cases the tumor had already reached such a size or had metastasized so widely, that complete removal was impossible, but in the one really operable case, the tumor was successfully removed. No statistics are available upon the effect of radiation on these tumors.

Ganglioneuroma is a relatively benign neoplasm arising from the ganglionic elements of the autonomic nervous system. In contrast to the neuroblastomata, the ganglioneuromata occur more commonly in adults, the average age in fifty-two cases being nineteen years. The youngest reported patient was four years of age and the oldest seventy-six. Sixty-two per cent of the cases occurred in females, while only thirty-eight per cent were in males. Of twenty-nine cases in which the side was indicated, twenty-five occurred on the left side of the body.

These tumors vary considerably in size, the reported cases varying from the size of a hen's egg to that of a child's head or larger. In Sauerbruch's case (reported by Brunner) the tumor measured 17 x 12 x 8 cm.

Due to their large fibrous content they are firm in consistency, presenting in the gross many of the characteristics of a fibroma. In some instances, the outer layers of the tumor compose a very firm, almost cartilaginous shell enclosing a mass of softer tissue. The cut surface is gray and glistening and appears to be relatively avascular, with fibrous tissue septa dividing the tumor into smaller lobules. Microscopically these neoplasms show a rather coarse, reticular arrangement of fibrous tissue in the interstices of which are contained strands of non-medullated and medullated nerve fibres. In the majority of cases the former type predominates. Intermingled with these fibres are found multipolar ganglion cells varying in number in different tumors and many of them showing signs of degenerative changes, such as vacuolization, etc.

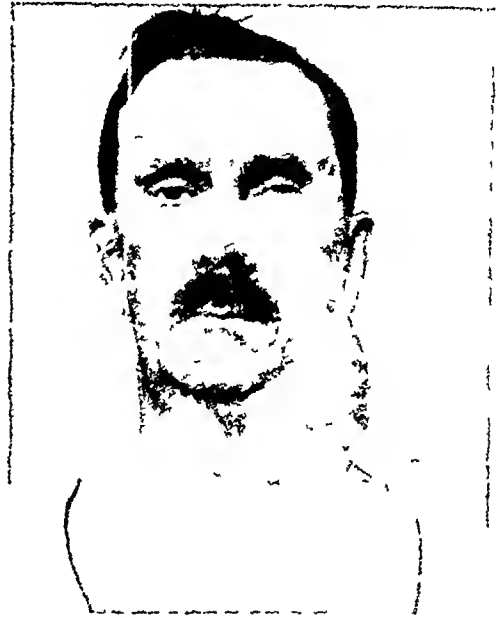


FIG. 6.—Paraganglioma of the carotid body (carotid body tumor). Duration of tumor eleven years. A diagnosis of carotid aneurism was made six years before removal of the tumor.

The ganglioneuromata are usually benign, as shown by the fact that they are of slow growth and may reach a considerable size before giving rise to symptoms. In Sato's case, the tumor was known to have been present for sixteen years before its operative removal, and several authors (Borst, Beneke, Ohse, Braun, Kreche and Brunner) have reported cases in which the tumor was as large as a child's head or larger. Also, in at least one case (Busse-Kredel), re-investigation of a ganglioneuroma, incompletely removed at operation five years previously, failed to reveal any recurrence.

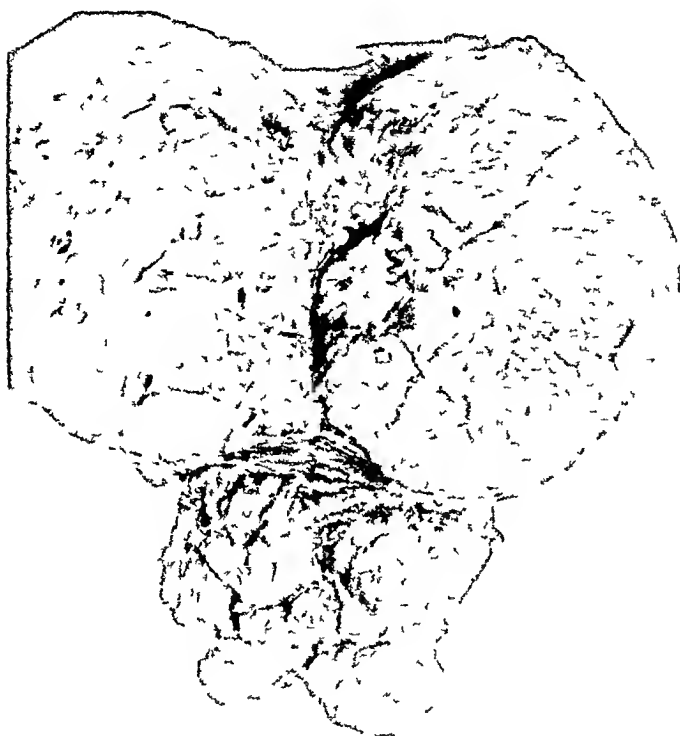


FIG. 7.—Carotid body tumor removed from the patient shown in Figure 6

In certain of the reported cases, ganglioneuromata seem to have possessed malignant characteristics. Thus, in Beneke's case, cell types and topography suggestive of neuroblastoma were found, and Berner and Miller found metastases from such a tumor in the neighboring lymph-nodes. Jacobstahl noted liver metastases, and Seefelder described metastases from a pelvic ganglioneuroma to the lymph-nodes, bones, and soft parts.

These cases have been taken to indicate malignant degeneration of ganglioneuromata. How-

ever, since combinations of neuroblastoma and ganglioneuroma are known to exist, it would seem more rational to consider these cases as neuroblastomata in parts of which more mature elements, *i. e.*, differentiated ganglion cells, are to be found. Indeed, it seems altogether likely that we have all gradations between pure neuroblastomata and pure ganglioneuromata and that the degree of benignancy corresponds quite accurately with the degree of differentiation to be found in the individual tumors.

The rather rare occurrence of ganglioneuromata in connection with peripheral nerves may be due to anomalous development, but is also to be explained on the basis of Alt's work in which he found numerous ganglion cells in the brachial and lumbo-sacral plexuses in dogs, cats, etc. The diffuse subcutaneous distribution in the case of Kredel-Beneke may have originated from the perivascular plexuses in which Glaser has demonstrated ganglion cells.

Ganglioneuromata produce relatively few symptoms and are often found

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in the course of some secondary condition. They sometimes produce paralysis by pressure. Thus deQueirvan noted ptosis and anisocoria in a cervical case, and Busse has described Kiedel's case in which a similar tumor in the lumbar region produced paralysis of the leg, bladder and rectum. Occasionally, as in Loretz's case, a tumor springing from the gray ramus may invade the spinal canal through the intervertebral foramina, and produce pressure on the cord or cauda equina while at the same time assuming proportions retroperitoneally or behind the pleura.

Since these tumors produce no intrinsically characteristic symptoms one can readily understand why a definite diagnosis in the absence of histological examination has never been made. Pressure symptoms attributable to the autonomic system should suggest such a diagnosis but since so many other and more common lesions may produce sympathetic paralysis, such evidence is only contributory. Of twenty cases operated upon, seventeen were cured at the time of the last report, while only three died, two from direct effects of the operation and one due to malignant changes in the tumor with metastases. In contrast to the neuroblastomata we see, therefore, that the ganglioneuromata are quite benign in their course and offer a relatively good prognosis.



FIG. 8.—Histological section of the carotid body tumor shown in Figure 7.

Paraganglioma.—While one branch of the neuroblast tree gives rise to the sympathetic ganglion cells, the other differentiates into the cells which by virtue of their chemical affinity for the salts of chromium, are spoken of as chromaffin cells. To the organs composed of chromaffin tissue, Kohn has given the name of paraganglia, and neoplasms of this tissue are called paragangliomata (Alezaïs and Peyron).

While, theoretically, paragangliomata may arise from any of the collections of chromaffin tissue, the greater number, by far, arise in the suprarenal medulla, the carotid gland, and the Gelben Zellen of the gastro-intestinal tract.

The paragangliomata of the suprarenal medulla are relatively rare, only about seventeen cases have been recorded since the first case was reported by Berdey in 1892. All reported cases have been quite benign and symptomless, being for the most part autopsy curiosities. As a rule, the tumors are small, varying from the size of a pinhead to aggregations a few centimetres in

diameter In the gross the tumor appears as an enlargement of the suprarenal gland, which on section, is seen to be due to a brownish-gray mass distending the cortex Microscopically, the tumors are composed of epithelial cells which are arranged in cords along delicately anastomosing capillaries and which, when stained with chrome salts, take a brownish color

In certain cases, notably those reported by Hedinger, Manasse, Marchetti and Suzuki and Zechmer, sympathetic ganglion cells and their less mature precursors have been found in the tumors, and, in these cases, the tumor was invading the cortex in a way which would indicate at least potential

malignancy The association of paraganglioma of the adrenal medulla with neurofibromatosis in fourteen reported instances (Herv-heimer-Kawashima, Suzuki and Zeckmer) is an interesting clinical observation

More numerous and far more important from the surgical standpoint are the paragangliomata of the carotid gland Marchand, in 1891, was the first to call attention to this tumor, while Paltauf, in 1892, reported four additional cases and, through his paper,



FIG 9.—The dotted line indicates how the bifurcation of the carotid artery was embedded in a paraganglioma of the carotid gland

established the condition as a clinical entity A survey of the literature reveals some 111 reported cases

Tumors of the carotid gland are found largely in adult life The average age is forty-one years, with the extremes in age of seven and seventy-four years Only six such tumors have been reported in patients under twenty years of age

In most instances the tumors had been present for some time before operation, in but fourteen instances had the tumor been present less than one year and in almost 60 per cent of the cases, a mass had been noted for more than three years Three patients dated the appearance of the growth from a time more than thirty years previous to operation In many of the cases however, in which the tumor had been present for more than a year or so, a more rapid growth during the months preceding operation was noted

For the most part the growth of the tumor is symptomless until it comes to cause pressure on the surrounding nerves or upon the pharynx or œsophagus Relatively small tumors may press upon certain nerves The vagus was most commonly involved (fourteen times), the hypoglossal next (seven times), the cervical sympathetic (five times), the glossopharyngeal (five times), and spinal accessory (twice) In some instances the patient may complain of pain in the throat, ear or base of the skull, or there may be atrophy of the corresponding half of the tongue or dysphagia The latter

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symptom may also be due to protrusion of the growth into the pharynx. Pressure upon the sympathetic chain may also give rise to anisocoria or enophthalmos, and in a few instances there has been aphonia and dyspnea due to pressure from large tumors.

Tumors of the carotid body have been variously regarded as peritheliomata, endotheliomata, epitheliomata, perithelial angiosarcomata or adenomata, due no doubt to slight variations in the histological structure. However, while hyperplasia or neoplastic growth of the structural elements of the carotid body aside from the chromaffin tissue does occur, the behavior of these tumors and the general similarity of their gross and histological appearance would seem to indicate that in most carotid body tumors, we are dealing with a certain pathological entity. Certain cases, notably two of those of Gilford and Dobromyslov's case seem to have been sarcomata, while Gilford has also reported a case which was probably a carcinoma.

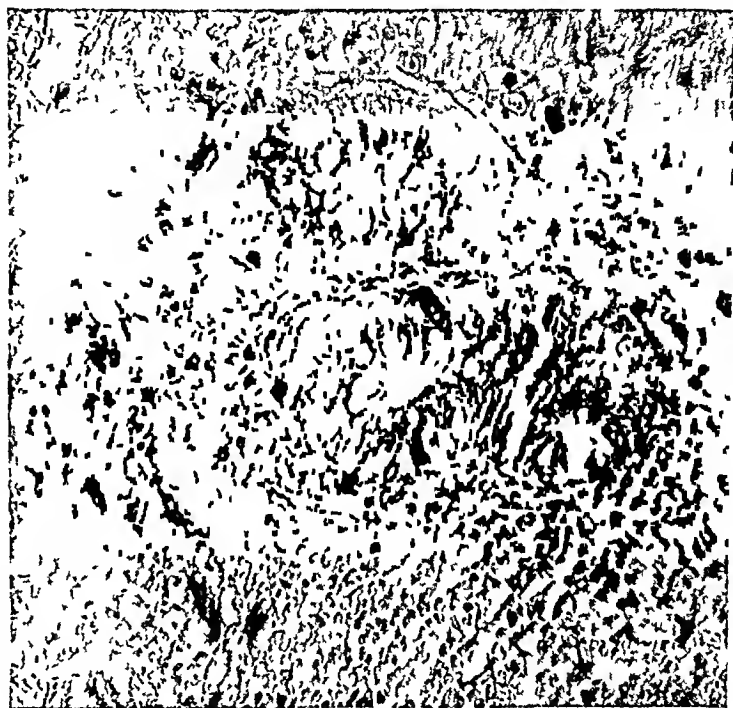


FIG 10.—The gelben zellen in the Crypts of Lieberkuhn of the appendix, darkly stained with silver (After Forbus)

Grossly, these tumors present as nodular masses which are of firm consistency and even texture, characteristics which prompted the suggestion of the appellation of "potato tumors" by Hutchinson and Gilford. On section, they are usually well encapsulated with fibrous tissue and the cut surface usually presents a yellow or orange color, varying to red with the vascularity of the tumor. In many instances, the great vascularity has suggested angio-sarcoma or even aneurism. The adjacent lymph-nodes are occasionally agglomerated with the tumor but are rarely involved by the growth.

Histologically, an alveolar topography is quite characteristic, the growth being composed of polyhedral granular cells arranged in compact groups and surrounded by hyperplastic capillary endothelium. The amount of stroma varies but is often scanty, the characteristic cells being in intimate contact with the capillary endothelium.

Because of the site of the carotid gland, tumors arising from it present a rather definite clinical picture and important neighboring structures so soon become involved that the surgical attack upon these tumors furnishes a very difficult problem.

Keen, writing on these tumors, mentions the following points which may aid in the diagnosis (1) The position at the bifurcation of the carotid artery, (2) movability laterally but not vertically, (3) ovoid shape, (4) smooth and not lobulated, (5) single, (6) transmitted pulsation, (7) bruit and thrill (8) bulging of the wall of the pharynx, (9) pupils occasionally constricted, (10) slow growth, (11) long duration, (12) a rather firm elastic consistency. Speaking negatively he says they are (1) Not tender, (2) not painful and (3) the deformity is the main complaint.

The position of the artery in these cases deserves further comment. Whereas other cervical growths may dislocate the artery, they usually leave it freely movable. In carotid body tumors the carotid artery is caught, fixed and carried lateralward so that it lies in a groove on the lateral or antero-lateral aspect of the tumor.

Since many of these tumors are extremely vascular, a palpable pulsation and associated bruit are frequently evident, and have been commented upon in twenty-two cases.

The surgical removal of carotid body tumors is fraught with a considerable danger and difficulty, because the frequent involvement of the carotid artery in the substance of the growth necessitates the ligation or excision of this vessel or even the entire neurovascular bundle. Of forty-three cases in which it was necessary to ligate the carotid artery, nineteen or forty-four per cent died. In addition, two other patients suffered hemiplegia. The concomitant ligation of the common carotid and internal jugular in fifteen cases was attended with a mortality of 54 per cent.

The mortality in the collected cases was about 40 per cent, certainly a high rate for an operation performed in the greater number of instances for cosmetic reasons. Such considerations have led several surgeons—Da Costa, Reclus and others, to advise against operation in the simple cases where a definite diagnosis has not been made before fixation and involvement of the neurovascular bundle has taken place.

Obendorfer (1907), separated from the true carcinomata of the gastro-intestinal tract a group of neoplasms to which he applied the name of *carcinoid tumors*, which, according to our classification, are called paragangliomata.

Hubschmann in 1910 (*Revue med de la Suisse rom*, 1910, vol xxx, p 317), suggested that these tumors had their origin in the so-called "Gelben Zellen" of the Crypts of Lieberkuhn, the chromaffin character of which had been proven by Schmidt in 1905. Gosset and Masson in 1914, (*Presse med*, vol xxii), studied these cells and the carcinoid tumors and concluded that the tumor cells are probably identical with the chromaffin tissue of the paraganglia. While the idea of the origin of the carcinoid tumors from chromaffin tissue has not been universally accepted, the findings of Gosset and Masson have been confirmed by other authors, notably by Hasegawa (1923), Damsch (1924), and Forbus (1925), and the weight of evidence

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seems to point to their endocrine origin. As such, they deserve consideration among the tumors of tissue related to the autonomic nervous system.

Pathologically, these tumors present as single or multinodular enlargements, occurring most commonly in the appendix and ileum, but being also found elsewhere in the gastro-intestinal tract. Occasionally they appear as a bulbous enlargement of the distal portion of the appendix. The incidence of their occurrence in appendices removed at operation is estimated at 0.4 per cent. The tumors are found in the submucosa but may extend into the muscularis or more rarely into the mesentery. Microscopically they are made up of rather round, oval or low cylindrical cells with round or oval nuclei, which stain quite deeply but do not exhibit much variation in size nor many mitotic figures. These cells are found in nests or alveoli, surrounded by interlacing trabeculae of fibrous or smooth muscle tissue. Because of the peculiar ability of certain of the cells to reduce silver from ammoniacal solution, the name of argentaffine tumors has been suggested. Clinically, these tumors are quite benign and seldom, if ever, produce symptoms of themselves.

Neuromata may develop in the sympathetic nerves just as well as in the peripheral nerves. Massary and Valser (*Soc. med. des Hopitaux*, January 29, 1923), reported a case of a tumor in the wall of the stomach, which they considered to have been derived from Schwann's syncytium, and because of the identity of this tissue with the central neuroglia, they regarded it as a glioma. The neuromata of the sympathetic nerves have been studied by Masson (*Thesis*, Paris, 1909), and Quirin (*Thesis*, Paris, 1921) has described the embryonal sympathomata. Both these classes of neoplasms present as non-malignant tumors, which occur more commonly in the uterus than in other viscera.

Careful study by Masson and by Askanazy, of the proliferation of the nerve elements about the margins of gastric ulcers and in the walls of previously inflamed appendices—particularly those of the chronic obliterative type—has convinced these authors that, in some instances, such an overgrowth may reach a true neoplastic grade. Dupuy (*International Clinics*, vol. IV, December 25, p. 164) has described a case of ulceration and chronic perforation of the gastric wall, in which there was a considerable hyperplasia of the cells and fibres composing Auerbach's plexus.

Leriche, Bettman and others, who have performed periarterial sympathectomy on the iliac arteries or upon the abdominal aorta, for intractable pelvic pain, base the rationale of the operation upon the idea that the pain is caused by neuromata formed in connection with the pelvic or uterine nerves—such as have been demonstrated in the uterus by Masson.

SUMMARY OF THE TUMORS OF THE AUTONOMIC NERVOUS SYSTEM

1 In the appendix	325
2 In the carotid body	111
3 In the suprarenal medulla	70

4 In the small intestine	17
5 In the stomach	2
6 In the central nervous system	18
7 In the cervical sympathetic chain	8
8 In the thoracic sympathetic chain	11
9 In the abdominal sympathetic chain	27
10 Miscellaneous tumors	21

With the two cases of "carcinoid" tumors of the appendix reported in this paper, we have collected 325 cases of paragangliomata of the appendix. In reviewing the literature, we have found twenty-five cases in which the appendiceal growth was definitely a carcinoma, some of which were of the colloid type. At the Mayo Clinic the incidence of appendiceal tumors was 0.44 per cent among the first 5000 cases of appendectomy reported, 0.6 per cent among the next 3039 cases. One case of the sixty-four appendiceal tumors reported from this clinic was definitely malignant. Stewart and Taylor report a "carcinoid" tumor of the appendix that caused a metastatic nodule in the pelvis, and claim to have found in the literature seventeen cases of "carcinoid" tumors associated with metastases. I agree with Forbus who doubts if true paragangliomata of the appendix and gastro-intestinal tract ever metastasize. This author has called attention to a peculiar adeno-carcinoma which superficially resembles "carcinoid" tumors but does not give any of the characteristic chemical or staining reactions. It will, however, produce extensive metastases.

We have collected 111 reported cases of carotid body tumors which, we believe had their origin from the chromaffin cells. This does not include the few cases of malignant tumors that have apparently developed in the stroma of this gland. Of the 111 cases, 110 may be classified as paragangliomata and one as neuroblastoma. Birnbois states that no improvement has resulted from radiotherapy and also, that no distant metastases have ever been observed. Collison and Machenty mention one case from the literature, in which metastases to the liver occurred. We could not find the original report of this case.

Of the seventy tumors of the suprarenal medulla, forty appear to be neuroblastomata, thirteen ganglioneuromata, and seventeen paragangliomata. The neuroblastomata were highly malignant, the other tumors were relatively benign.

Of the small intestine there are reported two neuroblastomata and fifteen paragangliomata ("carcinoid" tumors).

One neuroma and one peripheral glioma (neuroblastoma) are reported as occurring in the stomach.

There are eighteen tumors of the autonomic nervous system, which have been located in the region of the central nervous system—five neuroblastomata and thirteen ganglioneuromata. Of the ganglioneuromata, three were in the cerebrum, two in the cerebellum, two in the tuber cinereum, one in the

TUMORS OF THE AUTONOMIC NERVOUS SYSTEM

medulla, one in the gasserian ganglion, one in the pineal body, two in the dura and ependyma, and one in the spinal canal

Eight tumors of the cervical sympathetic chain have been recorded—two neuroblastomata and six ganglioneuromata

Eleven tumors of the thoracic sympathetic chain have been reported—three neuroblastomata and eight ganglioneuromata

Of the twenty-seven tumors of the abdominal sympathetic chain, seven were neuroblastomata, sixteen ganglioneuromata, and four paragangliomata

Of the twenty-one miscellaneous tumors listed in the chart, there are five neuroblastomata—one in the retina, one in the nasal cavity, one in the uterus and two in the coccygeal gland, twelve ganglioneuromata—one in the sphenomaxillary fossa, one in the eye-lid, one in the nares, one in the mesentery, three in the pelvis, one in the sacral region, two in the subcutaneous tissue, one in the chin and one in the knee-joint, and four paragangliomata—one in the aortic ganglion, one in the retroperitoneal tissue and two in the upper pole of the kidney (possibly in the suprarenal gland)

Very little has been written about neuromata of the autonomic nervous system. Consequently our statistics do not convey any accurate idea as to the incidence of this condition

TUMORS OF THE SUPRARENAL MEDULLA

Classified According to Type, and the Authors Reporting Them Neuroblastomata

Dalton, 1885	1	Hertz and Secher, 1918	1
Marchand, 1891	1	Wolbach and Morse, 1918	3
Orr, 1900	1	Gunby, 1920	1
Amberg, 1904	1	Carter, 1921	3
Richards, 1905	1	Van Dam, 1924	2
Kuster, 1905	1	Boyd, 1926	1
Lapointe and Lacene, 1907	1	Lederer, 1926	1
Tileston and Wolbach, 1908	1	Bendixes and Lamb, 1926	1
Wright, 1910	1	Meltzer, 1926	2
Landau, 1912	2	Kawatin and Twiss, 1927	3
Herxheimer, 1913	1	Saphis, 1927	1
Wahl, 1914	1	Gibson, 1927	2
Dunn, 1915	1	Sturtevant and Heller, 1927	1
Glosmet, 1915	1		—
Harbitz, 1915	2	Total cases	40
Lehman, 1917	1		

Ganglioneuromata

Weichselbaum, 1881	1	Oberndorfer, 1907	1
Busse and Kredel, 1898	1	Miller, 1908	1
Schmidt, 1899	1	Hook, 1911	1
Bruchanow, 1899	1	Dunn, 1915	1
Beneke, 1901	1	Berner, 1922	1
Fabris, 1903	1		—
Ribbert, 1904	2	Total cases	13

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Paragangliomata

Berdez, 1892	1	Wegelin, 1912	1
Manasse, 1896	1	Thomas, 1913	1
Marchetti, 1904	1	Ewing, 1922	1
Laignel Lavastine, 1908	1	Zweiker, 1925	1
Alezais et Peyron, 1911	1	Bonnamour et al, 1927	1
Suzuki, 1910	3	Oberling et Jung, 1927	1
Hedinger, 1911	1		—
Kawashima, 1911	1	Total cases	17
Herde, 1912	1	Grand total	70 Cases

DISTRIBUTION OF TUMORS OF THE AUTONOMIC NERVOUS SYSTEM

Classified According to Type, and the Authors Reporting Them

New blastomata

<i>Location</i>	<i>Author</i>	<i>Number of Cases</i>
Central nervous system	Marchand, 1907	1
Central nervous system	Bailey and Cushing 1926	3
Central nervous system	Silverberg, 1926	1
Retina	Boyd, 1926	1
Cavity of nose	Wolbach, 1911	1
Cervical sympathetic chain	Martius, 1913	1
Cervical sympathetic chain	Capaldi, 1927	1
Thoracic sympathetic chain	Anderson and Sheenan, 1923	1
Thoracic sympathetic chain	Cabot, 1927	1
Thoracic sympathetic chain	Capaldi, 1927	1
Abdominal sympathetic chain	Hecht, 1909	1
Abdominal sympathetic chain	Schilder, 1909	1
Abdominal sympathetic chain	Wright, 1910	1
Abdominal sympathetic chain	Landau, 1912	1
Abdominal sympathetic chain	Anitschkow, 1913	1
Abdominal sympathetic chain	Boyd, 1926	1
Abdominal sympathetic chain	Karelitz, 1927	1
Uterus	Pick, 1912	1
Coccygeal (gland) region	Alezais and Imbert, 1907	1
Coccygeal (gland) region	Harbitz, 1915	1
	Total cases	22

Ganglioneuromata

Central nervous system (cerebrum)	Worcester, 1901	1
Central nervous system (cerebrum)	Dumas, 1904	1
Central nervous system (cerebrum)	Schmincke, 1910	1
Central nervous system (cerebellum)	Achucarro, 1913	1
Central nervous system (cerebellum)	Lhermitte, 1920	1
Central nervous system (tuber cinereum)	Robertson, 1915	1
Central nervous system (tuber cinereum)	Greenfield, 1919	1
Central nervous system (medulla)	Pick and Bielschowsky, 1911	1
Central nervous system (gasserian ganglion)	Risel and Zwickaw, 1909	1
Central nervous system (pineal body)	Cushing and Wolbach, 1927	1
Central nervous system (dura and ependyma)	Haenel, 1899	1
Central nervous system (dura and ependyma)	Bielschowsky, 1925	1

TUMORS OF THE AUTONOMIC NERVOUS SYSTEM

Ganglioncomata—Continued

Central nervous system (spinal canal)	Cushing and Wolbach, 1927	I
Spheno-maxillary fossa	Dunn, 1915	I
Eye-lid	Krauss, 1911	I
Nares	And Key, 1879	I
Cervical sympathetic chain	Benda, 1904	I
Cervical sympathetic chain	Glinski, 1906	I
Cervical sympathetic chain	Woods, 1906	I
Cervical sympathetic chain	Frcund, 1913	I
Cervical sympathetic chain	Sommerfelt, 1920	I
Cervical sympathetic chain	Stout, 1924	I
Thoracic sympathetic chain	Lortz, 1870	I
Thoracic sympathetic chain	Tschistowitsch, 1908	I
Thoracic sympathetic chain	Friedrich, 1911	I
Thoracic sympathetic chain	Rosenson, 1923	I
Thoracic sympathetic chain	Brunner, 1924	I
Thoracic sympathetic chain	Stout, 1924	I
Abdominal sympathetic chain	Busse, 1897	I
Abdominal sympathetic chain	Cripps and Williamson, 1899	I
Abdominal sympathetic chain	Beneke, 1901	I
Abdominal sympathetic chain	Rosenbach, 1901	I
Abdominal sympathetic chain	Glockner, 1902	I
Abdominal sympathetic chain	Ohse, 1906	I
Abdominal sympathetic chain	Falk, 1907	I
Abdominal sympathetic chain	Braun, 1908	I
Abdominal sympathetic chain	Oelsner, 1908	I
Abdominal sympathetic chain	Miller, 1908	I
Abdominal sympathetic chain	Sato, 1912	I
Abdominal sympathetic chain	McNaughton-Jones, 1912	I
Abdominal sympathetic chain	Jacobsthal, 1909	I
Abdominal sympathetic chain	Peters, 1913	I
Abdominal sympathetic chain	Adams, 1914	I
Abdominal sympathetic chain	Berner, 1922	I
Mesentery	Peterson, 1913	I
Pelvis	Beneke, 1901	I
Pelvis	Schorr, 1910	I
Pelvis	Stoeckel, 1923	I
Sacral region	McNaughton-Jones, 1912	I
Subcutaneous tissues	Knauss, 1898	I
Subcutaneous tissues	Kredel and Beneke, 1902	I
Chin	Chiari, 1898	I
Knee-joint	Hagenbach, 1910	I
Total cases		55

Paragangliomata

Aortic ganglion	Stangl, 1902	I
Retroperitoneal	Vecchi, 1905	I
Upper pole kidney (suprarenal?)	Weisel, 1902	I
Upper pole kidney (suprarenal?)	Stoerk	I
Total cases		4
(Grand total)		81 Cases

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OPERATION FOR THE RADICAL CURE OF TRIGEMINAL * NEURALGIA

ANALYSIS OF FIVE HUNDRED CASES

BY CHARLES H FRAZIER, M D
OF PHILADELPHIA, PA

Foreword by WILLIAM G SPILLER, M D—It is a pleasure to write a foreword to an article by Dr Frazier on tic douloureux. In the years 1901, 1902, 1903 and 1904 he and I published a series of papers presenting the results of our studies on the trigeminal nerve.

The subtotal division of the sensory root of this nerve is a great advance in the surgery of tic douloureux. This operation was devised and first performed by Frazier in 1915, and in 1925 (*Archives Neurol and Psychiat*, March, 1925) he recorded twenty-five cases in which he had performed it successfully. It had solid foundation. In the paper published by him and myself in 1901 (*Phila Med Journal*, Dec 14, 1901) where he described the first case in which the total division of the sensory root was done deliberately with complete success in substitution for removal of the ganglion, statements were made by me regarding the anatomical arrangement of the fibres in the sensory root of dogs on which operation had been performed. The sensory root in a few dogs was not completely divided in its inner portion, and from a study of the spinal root in the medulla oblongata conclusions were drawn relative to the definite arrangement of its fibres. I was able to show that the nerve fibres of the sensory root in both its intracerebral and extracerebral portions maintain the same relative positions throughout the course of this root. This fact also was elaborated in our paper published in the *Journ Amer Med Assoc*, Oct 1, 1904, and the situation of the fibres of the ophthalmic division was determined.

One might suppose that Frazier as a result of this experimental work in 1901 would have suggested the subtotal division of the sensory root. At that time we did not have satisfactory assurance that regeneration of the sensory root was impossible, and in 1903 we published the results of further experimental studies to settle this point. We found that the posterior spinal roots in the dog when cut did not regenerate (*University of Penna Med Bul*, June, 1903). It was probable that the sensory root of the trigeminal nerve being similar would behave in a like manner.

Although we had received very generous recognition of our work by Van Gehuchten (*Le Névralgie*, vol v) we felt that it was necessary to establish the operation of total division of the sensory root upon a firm basis as a proper surgical procedure, and it was not until Frazier had performed this operation many times, and had noticed in his cases the usual escape of the ophthalmic division in the pain of tic douloureux that he could venture

* Read by title

THE RADICAL CURE OF TRIGEMINAL NEURALGIA

to spare the inner portion of the sensory root The paper by Frazier and Whitehead (*Brain*, vol xlviii, part iv, 1926, p 458) established further the anatomical divisions of the ganglion and sensory root by embryological development

It may be that the ophthalmic division of the trigeminal nerve is phylogenetically older than the other two divisions, although I do not have proof of this, and is therefore more resistant to pain, as phylogenetically new tissue is more susceptible to adverse conditions This possibility is suggested by the fact that Whitehead found that the ophthalmic portion is more precocious in its development The cells in this region develop their fibre processes earlier and the cells become arranged in clusters sooner than do the cells of other regions

It was in 1919 that Frazier reported that he had succeeded in operating with preservation of the motor root, but in our paper published in 1901 cited above I mentioned that he had saved the motor root of the dog in operation on the sensory root, and that the motor root in man probably would likewise be saved, yet in 1902 this seemed impossible to Keen and Frazier (footnote, *Phila Med Journ*, Oct 25, 1902, Frazier and Spiller) The preservation of the motor root is a great advance in the surgery of the trigeminal nerve, as shown by Frazier (*Journ Amer Med Assoc*, Nov 20, 1926, vol lxxxvii, p 1730)

OPERATIVE DISCUSSION BY DOCTOR FRAZIER

IN THE Neurosurgical Clinic of the University of Pennsylvania Hospital more than 500 major operations have been performed for the relief of major trigeminal neuralgia To be precise, the exact number of major operations (April 30, 1928) performed is 511 From the first to the last operation twenty-seven years have elapsed and during this period there has been an unusual wealth of material for observation and treatment, altogether upwards of 1200 cases of major neuralgia, not including some 248 of the atypical forms A number of contributions have appeared from the clinic during the period, touching on various aspects of this subject, but it seems, upon the completion of these 500 major operations, a fitting time to summarize our impressions of this disease, to write up the experience of the operator in matters of technic, to record our knowledge of the patients' reactions before and after the operation This purports to be a chronicle of events for this quarter of a century, as they relate to the problem of trigeminal neuralgia only in this clinic

Clinical Conceptions —I have nothing to add to that description of Fothergill of the year 1776 It is a vivid, accurate description of what might be said to be a prototype We should accept Fothergill's picture as a faithful portrayal of the disease There are, however, many side lights There is a tremendous variation in the severity of the pain But insofar as one can judge from the observation of a patient during his paroxysms, in the minority rather than in the majority does the patient appear to be a subject of terrific

pain I recall a patient who sat for three weeks in a darkened room, carefully screened to prevent a fly lodging on the face, not venturing to speak, on a liquid diet taken through a glass tube inserted in the angle of the mouth on the unaffected side—a pathetic subject, living in mortal terror of a paroxysm. This was a case of exceptional severity. The great majority of patients continue without interruption of their daily tasks. When, as on one occasion, I was asked to see a patient who was content to lie abed in a comfortable private room for three weeks, with the daily solicitation of nurses and doctors, I questioned at once the diagnosis and my suspicions proved true, for, after an operation performed elsewhere, contrary to my advice, the patient complained more of the numbness than she had previously complained of the pain. Despite the paroxysmal pain, patients with major trigeminal neuralgia are ambulant patients and prefer the distraction of their daily activities to the monotony of the sick room.

So far as one can judge from the facial expression, in many cases the patient's estimation of the violence of his paroxysm tends to exaggeration. No doubt the accumulative experience breaks down his morale, exhausts his endurance and the pains, at first tolerated with a certain amount of composure, later seem unbearable. A patient when asked how severe his paroxysms were, said, "It is a thousand times worse than a jumping toothache," and yet so far as one could judge from observation this seemed to be a gross exaggeration.

Is there any other disease in the category of human ailment where the diagnostician must rely wholly upon the patient's words, with evidence wholly subjective and not an objective sign? Is there any greater opportunity for malingering? You or I could so faithfully describe the symptoms as to satisfy the examiner that we were fit subjects for the major operation. What controvertible evidence could be discovered to expose the fraud?

After years of daily contacts and living with these patients, I have been forced to the conclusion that they are troubled in their souls as much by apprehension as by the actual exhibition of pain. This may appear to be an unwarranted statement, acknowledgedly difficult to support with proof, yet frequent questioning and conversations with the patients seem to substantiate this belief.

The classical description of major trigeminal neuralgia specifies total freedom from pain between the paroxysms. This is not altogether true. A number of patients record a sense of soreness in the painful zone in the intervals. It specifies that there are intervals of weeks or months between attacks. Exception must be taken to this too, as time goes on the paroxysms are of daily occurrence without interruption.

Of the etiology of trigeminal neuralgia we know as little today as we did twenty-five years ago. It is with some embarrassment that we must acknowledge, despite the wealth of opportunity for observation, no outstanding addition to any essential feature of the disease. Major trigeminal neuralgia is a disease of unknown etiology, spontaneous in origin and continuing uninterrupted throughout the patient's life unless arrested by well-recognized pro-

THE RADICAL CURE OF TRIGEMINAL NEURALGIA

cedures Not a single instance of spontaneous cessation has been recorded

Its differentiation from other forms of neuralgias should be unerringly made Its earmarks are so unmistakable that errors in diagnosis are now unwarranted Should there be a vestige of doubt this may be removed by an intraneural injection of novocain or a weak solution of alcohol The nearest approach to the clinical picture of true trigeminal neuralgia is that of tumors of the Gasserian ganglion In the intensity of the pain, in its paroxysmal character, and anatomical distribution, there is a very striking similarity, but a careful examination will in time detect some objective disturbances of sensation, often first of the conjunctiva One may be misled occasionally and chiefly because of the pain distribution of malignant growths, extracranial that

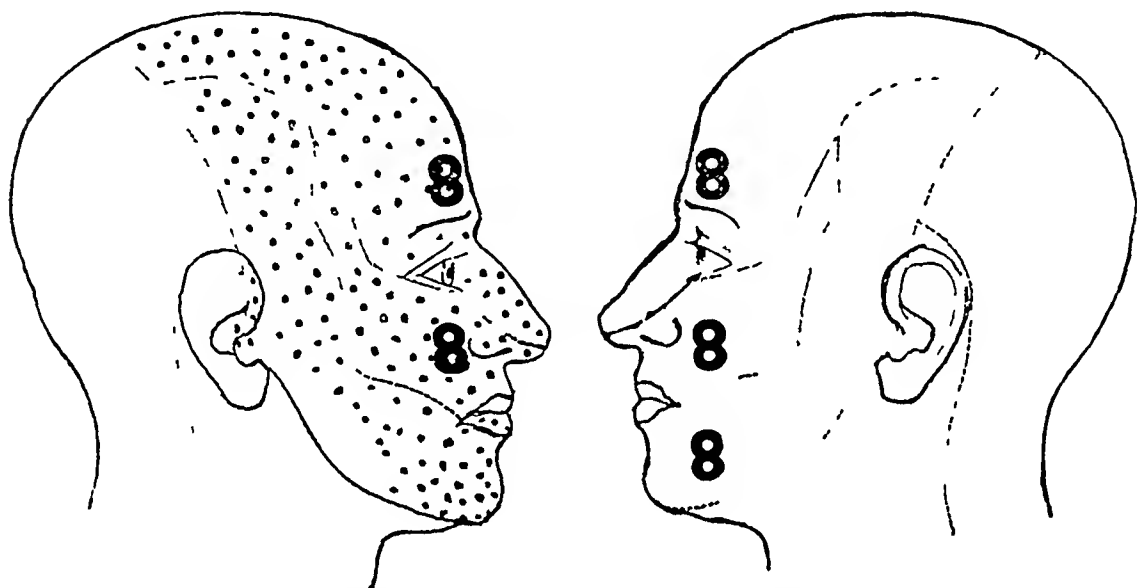


FIG 1.—Record of pressure sensation following subtotal section of the sensory root The dotted area indicates complete loss of sensation for touch, pain and temperature The figures represent kilograms of pressure as registered by the algometer in a comparative test on the operated and unoperated side

invade the second or third divisions at their exit from the skull Obscure carcinomata of the maxillary antra may erode the posterior wall of the sinus and, still unrecognized and unsuspected, infiltrate the mandibular and maxillary divisions

There is no excuse for confusing major trigeminal neuralgia with other pain pictures, with sphenopalatine neurosis, if there be such a clinical entity, with so-called glossopharyngeal neuralgia, an instance of which is not included in our 1214 cases, or with that medley of neuralgias which, for want of a better understanding, are called "atypical" These all are horses of a different color and should readily be recognized as such

Physiological Problems—It is acknowledged that the trigeminal nerve is a nerve of perception for pain, for touch and for temperature From numerous observations made after section of the sensory root, we find no reason to qualify this statement in the slightest particular That the trigeminal nerve supplies sense of taste to the anterior two-thirds of the tongue may be accepted without question In an effort to find some explanation for the

atypical neuralgias we have surveyed the entire afferent system—the trigeminus, the facialis, sympatheticus (No attempt has been made to invade the field of the other cranial nerves) When opportunity offered, tests for all forms of sensation have been made (For these tests I am indebted to Dr E C Russell)

- 1 In paralysis of the trigeminus alone (Fig 1)
- 2 In paralysis of the trigeminus plus facial paralysis (Fig 2)
- 3 In paralysis of the trigeminus plus periarterial sympathectomy (common carotid artery) (Fig 3)
- 4 In paralysis of the facialis without trigeminal or sympathetic disturbance (Fig 4)

As for the sympathetic system, we have no evidence that any form of sen-

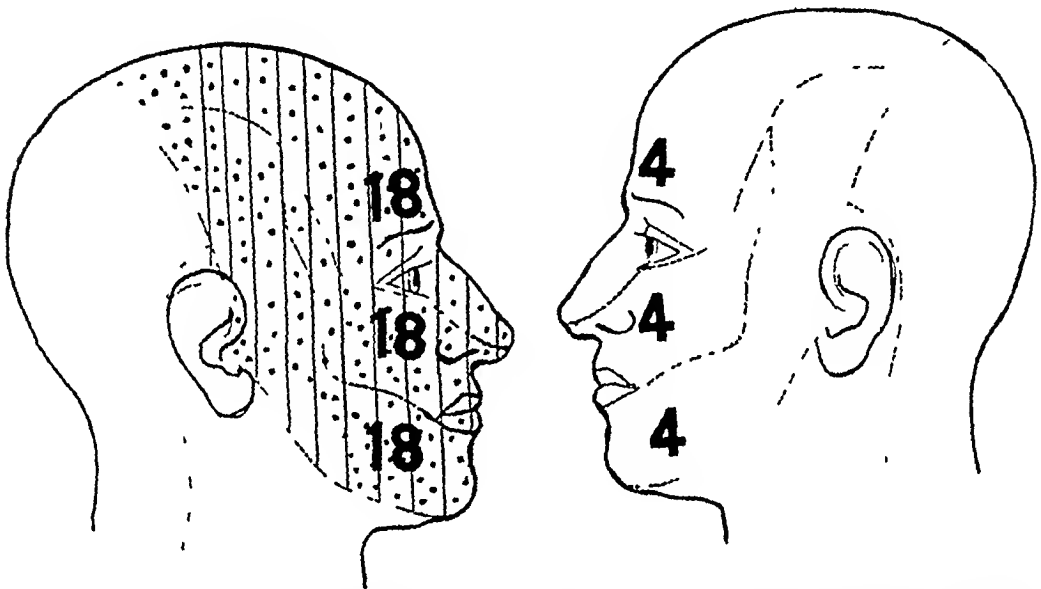


FIG 2—Record of pressure sensation following subtotal section of the sensory root. The dotted area indicates complete loss of sensation for touch pain and temperature. The lines indicate a complete paralysis of the peripheral type of the seventh nerve. Figures represent kilograms of pressure as registered by the algometer in a comparative test on the operated and unoperated side.

sation, that is the appreciation of pain, of touch or of temperature, is in any way influenced after excision of the superior ganglion with or without stripping of the periarterial plexus of the common carotid. That vague and varying pains have been experienced upon electric stimulation of the sympathetic we have recorded elsewhere. Similarly have we made note of the pains referred to within the trigeminal zone upon ligation of certain vessels, especially the superior thyroid artery. Anent the question of vascular origin of certain pain syndromes not of trigeminal origin observations have been made in the clinic as to the relation of vascular distribution to these pain zones. These observations proved futile.

To the facial nerve has been ascribed the perception of pressure sense (by Spiller, Ivy and Johnson, Davis, Gerard, Douques and Hartmann—*Arch Neurol and Psych*, 1928, vol xix, No 4, p 699). When opportunity offered, in cases with paralysis of both trigeminus and facialis, the perception of pressure and of pressure-pain has been recorded. These observations have been quite constant and are represented in the accompanying chart (See Fig 1).

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In this one sees recorded in terms of the pressure manometer the variations in degree

Anatomical Data—A study of the development of the sensory root and Gasserian ganglion in the fetus has been recorded (*Brain*, Vol XLVIII, Part 4, 1926) This study gave us a conception of the structures of root and ganglion, not hitherto appreciated, and of great practical import in the interpretation of certain clinical aspects of trigeminal neuralgia We found the sensory root composed of three separate and distinct bundles, one for each of the three portions of the ganglion, the ophthalmic, maxillary and mandibular We found the motor root, as it passed behind the ganglion, received fibres from the ganglion (Fig 5) We found that in the development of the ganglion the ophthalmic portion exhibits a certain isolation from the other two portions, as though nature intended some differentiation in

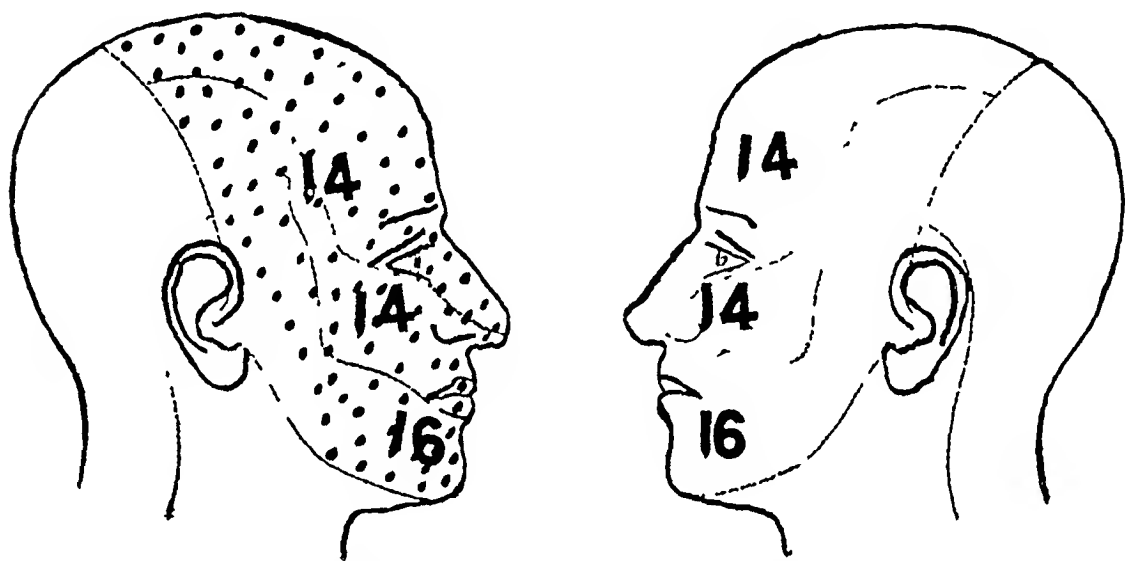


FIG 3—Record of pressure sensation following subtotal section of the sensory root. The dotted area represents complete loss of sensation for touch, pain and temperature. Note blockage of the sympathetic in addition to a complete sensory paralysis of the fifth does not alter relationship of pressure readings. Figures represent kilograms of pressure as registered by the algometer in comparative test on operated and unoperated side.

function, as in certain lower forms of animal life when there is an entirely separate and distinct ganglion for the ophthalmic distribution. We found a free intermingling of the fibres given off from the middle and outer portions of the ganglion to the maxillary and mandibular divisions. We saw in these embryological features an explanation for the more frequent association of pain in the maxillary and mandibular divisions, and the infrequent association of pain in the ophthalmic division with pain in the other two divisions (Fig 6)

One might claim an intimate acquaintance with the gross anatomy of the middle fossa after 500 or more observations in as many operations. On a small scale the variations may not appear striking, but if the scale were amplified to any considerable degree, the variation in structure would be amazing. It would be a gross exaggeration to say that no two middle fossæ look

exactly alike and yet one never exposes a middle fossa without the feeling that in minute particulars it is different

But speaking in more specific terms, there unquestionably are two gross patterns of the middle fossa, one common to the brachycephalic and one common to the dolichocephalic skull (Fig 7) In the broad brachycephalic skull the plane of the middle fossa is horizontal and the angle of the petrous process of the temporal bone less acute In the narrow and longer dolichocephalic skull there is a sharp pitch or declivity to the plane of the middle fossa and the petrous process describes a more acute angle A clearer concept of the difference between these two extreme types, between which there are of course gradations, might be had were one to fashion a brachycephalic skull of a

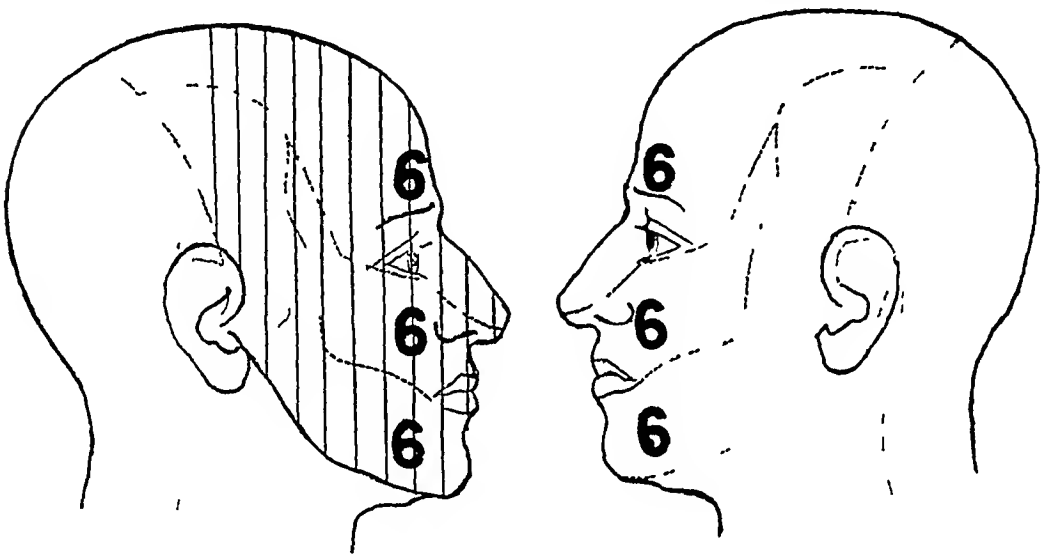


FIG 4—Record of pressure sensation in a complete paralysis of the seventh nerve. Figures represent kilograms of pressure as registered by the algometer in comparative test on the two sides

plastic material Lateral compression of the plastic structure would narrow the transverse diameter, increase the longitudinal diameter, increase the vertical diameter, thus deepening the floor and increasing the angle of the petrous bone (See Fig 8) The practical significance of these differences in anatomical types is obvious In the broad, flat skull the ganglion is more readily exposed and with less elevation of the temporal lobe, and the foramen ovale and the region of the ganglion is more nearly on a line almost at right angles to the zygoma from its midpoint Whereas in the long narrow skull, with its deep fossa, with the petrous bone at a sharper angle, our objectives lie not only on a deeper plane, but have been moved further forward At first glance of a patient with a broad skull, one's original impression might be that the sensory root would be more distant and therefore more difficult of exposure than with the narrow skull As a matter of fact, it is the reverse This, perhaps, is the most striking variation in the operative field, viewed as a whole There are many minute variations of which the following may be cited as an example External to the foramen ovale there is a bony eminence This may vary from a dome like structure or a bony

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ridge, to the most minute spicule of bone. If very small it is disregarded. If larger it is removed with a chisel even though it may be only two, three or four millimetres in height.

An interesting observation was made by one of my staff (Gardner). It was discovered after operation, by accident, that one patient had had a hemorrhage in the middle ear. After this observation the auditory canal was examined routinely, and in several other cases the same complication occurred. In searching for an explanation, Gardner found there was a branch of the

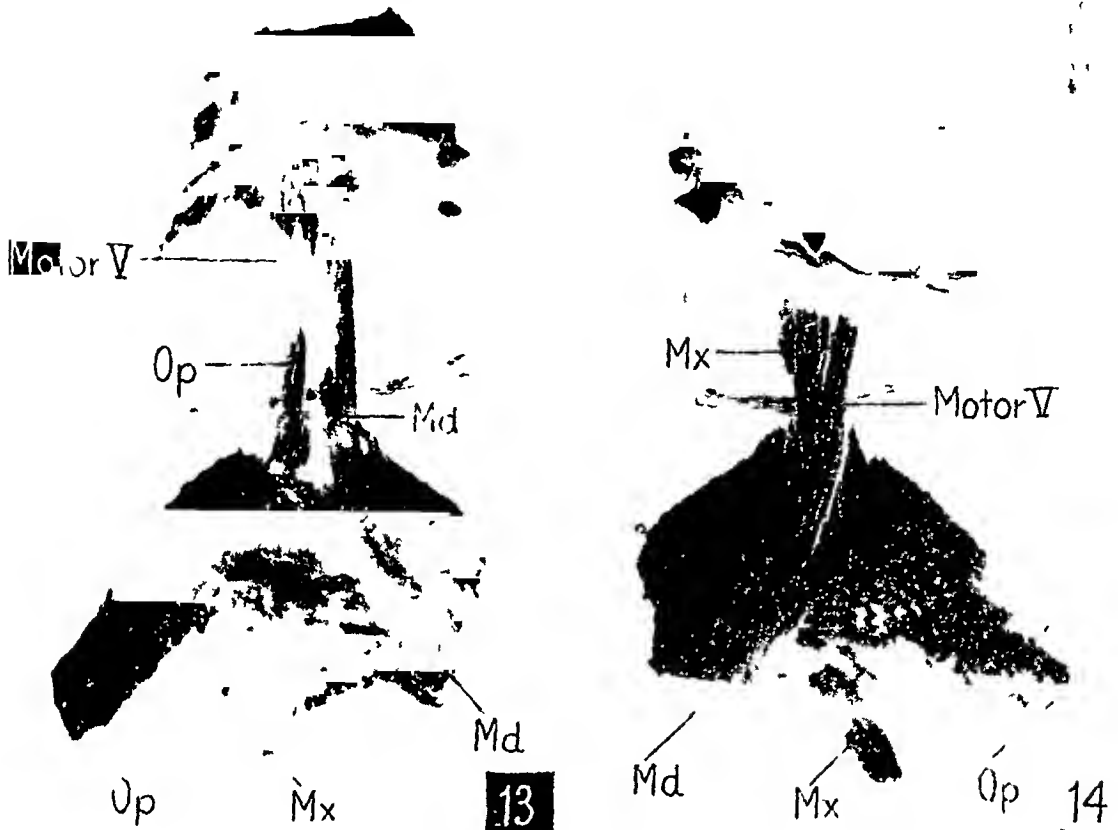


FIG 5—Ventral and dorsal views of a dissection of the left semilunar ganglion of a human fetus (No 2519) 238 mm crown rump length with an estimated age of twenty eight weeks. The sensory root can be seen emerging from the hilum of the ganglion and the different portions of the root are indicated by a wisp of silk thread inserted between the maxillary, on the one hand, and the ophthalmic and mandibular, on the other. The surface of the ganglion, when looked at under the binocular microscope, can be seen to be covered with a sheet of fibres which are passing peripheralward to form the individual nerve trunks. The origin of the motor division can be seen in Fig 13, and in Fig 14 it can be seen to pick up processes from the maxillary portion of the ganglion on its way to join the mandibular nerve.

middle meningeal vein taking its origin in the middle ear and making its exit through the hiatus Fallopi. In separating the dura from the skull this branch is torn and the obstruction to the venous outlet evidently precipitates hemorrhage in the middle ear. Since this observation was made we have been able to identify the point at which this tiny vascular connection leaves the dura and penetrates the skull.

Of the possible sources of hemorrhage, anatomical works do not describe in detail or dignify with any special name a venous channel in such close relationship with the ganglion that it is readily exposed to rupture. This venous channel as one sees it in this operation follows a course from a point adjacent

to the posterior margin of the ganglion arching over the ganglion. As the dura is elevated with retractor, it is almost in immediate contact with the maxillary division and when torn it is usually at this point. To secure perfect hæmostasis after the operation one should know just where a muscle graft should be placed to control hemorrhage of this origin.

The variation in the size of the ganglion is a commonplace observation. Sometimes the distance between the points at which the maxillary and mandibular divisions are given off to the sensory root is but a fraction of a centi-

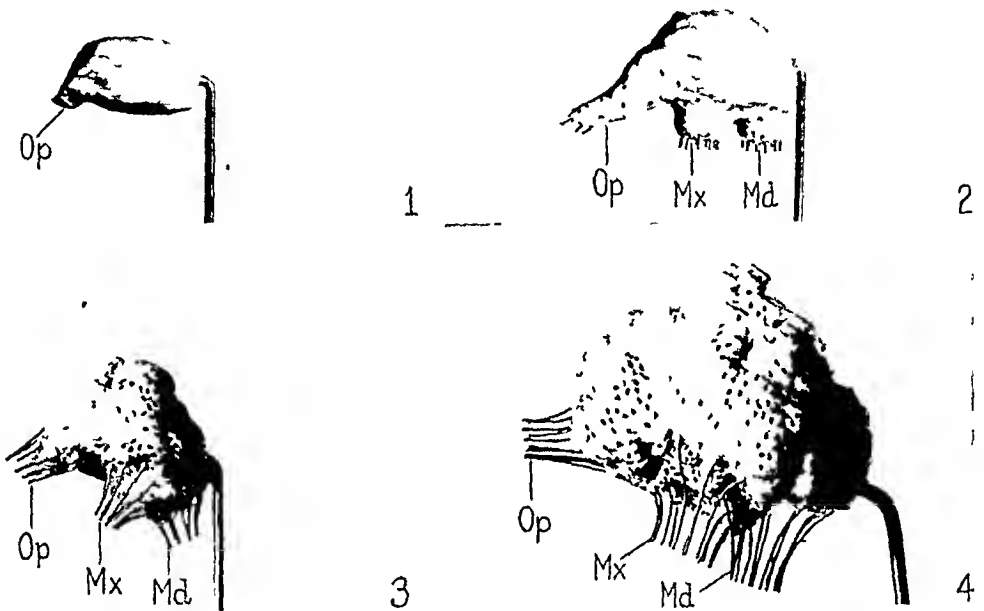


FIG 6—These illustrations were made from embryologic models of the semilunar ganglion from the human subject at various stages of development. One notices especially the precocity in the development of the ophthalmic divisions, its aloofness from the mandibular and maxillary divisions and the close association of the latter two.

metre. The longer the intracranial sections of these two divisions, the smaller it seems is the ganglion. Perhaps more a matter of pathological than anatomical interest is the difference in the constitution of the sensory root. To cite two extremes: in the one case a root with fasciculi and bundles easily separated one from the other, in the other a root in which the fasciculi seem to adhere snugly, so that not only is separation of the bundles not easy, but there is a snug adherence of the arachnoid to the root. These findings one can explain only on the assumption of a preexisting inflammatory process. Not only in the structure of the root but in the adhesions one finds between dura and skull, and especially between dura and ganglion, one must postulate a preexisting basilar meningitis. That this may play a part as an etiologic factor in some cases is a reasonable assumption.

Besides these variations in the structures of the sensory root, one finds variations in the structure of the motor root. Not only does the motor root vary in size but instead of a single fasciculus as in the majority of cases there may be two distinct fasciculi. One should bear this in mind as one

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might be tempted to divide one or the other of these in the thought that it might belong to the sensory root. But on careful inspection one can readily see that both fasciculi pass behind the ganglion.

The incidence of facial paralysis as a complication or sequel of the radical operation has long been a perplexing problem. About once in twenty-five operations this complication will follow the operation at varying periods. Never immediately after the operation, but usually at the end of the first twenty-four hours and before the lapse of forty-eight hours. In one instance

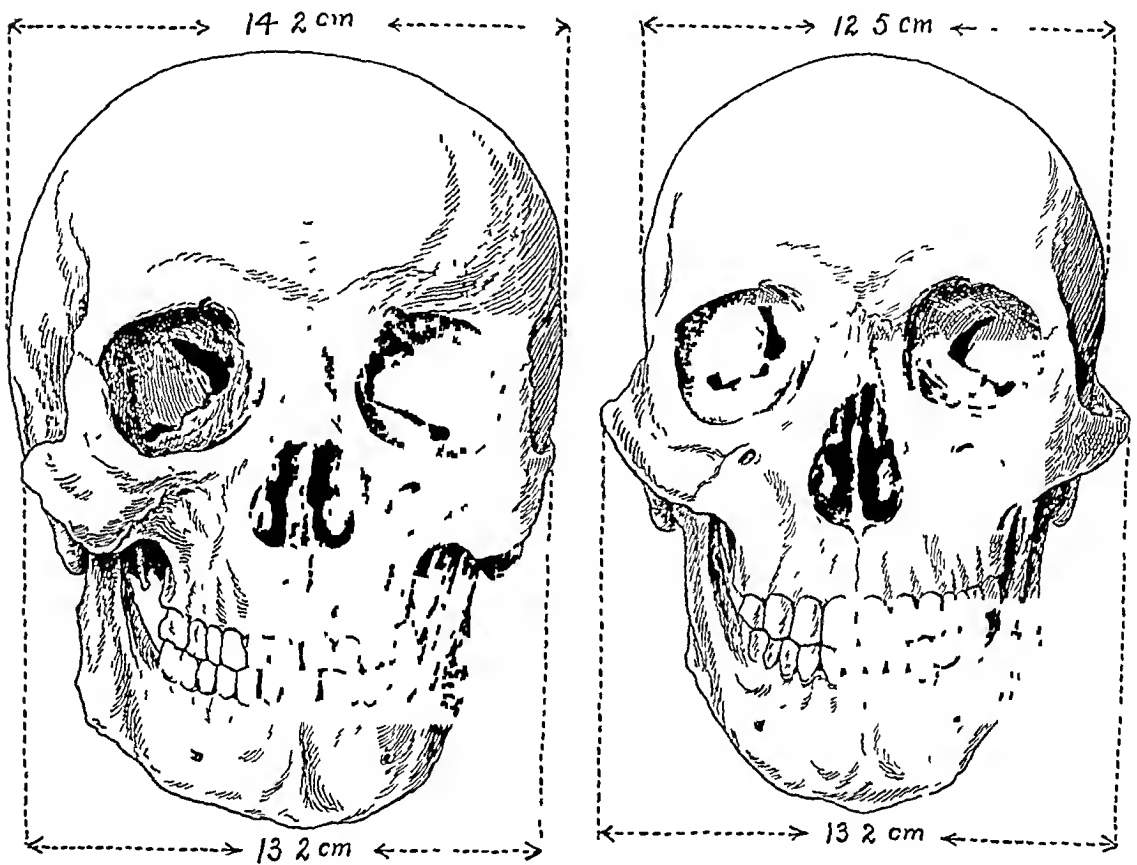


FIG 7—Brachycephalic skull. Dolichocephalic skull. These illustrations are drawn to scale from actual specimens and illustrate the fact that the bizygomatic diameters in the two skulls are exactly the same (13 2 cm) although the biparietal diameter of the broad skull is 14 2 cm while that of the narrow skull is 12 5 cm.

the paralysis did not develop until after the patient had been discharged. Obviously the lesion of the facial nerve must be of indirect origin, as the nerve is not within the operative field, either within or without the skull. In the days of the original Hartley-Krause operation, the anterior limb of the prescribed horseshoe incision might well sever the supply to the occipitofrontalis, and sometimes to the orbicularis palpebrarum, but the paralysis we are discussing involves the entire facial distribution and not only the upper branches. The only conceivable relation between the field of operation and the main trunk of the facial nerve is through the branch of the great superficial petrosal nerve. In its course this nerve lies nearest the operative procedure on the base of the skull posterior to the ganglion. It is protected by a process of the dura and it is my belief that when the base of the skull is

bared of this process the nerve is exposed to damage and possibly by traction or by hemorrhage within its sheath the parent trunk of the nervus facialis suffers. The tardiness with which the paralysis develops after the operation rather bespeaks hemorrhage as the cause. Certainly the paralysis could not be due to any damage to the nuclear centre. Fortunately the prognosis is always good. While it is a matter of some chagrin to the operator, the patient can be assured that the paralysis is only transitory. Recovery as a rule is

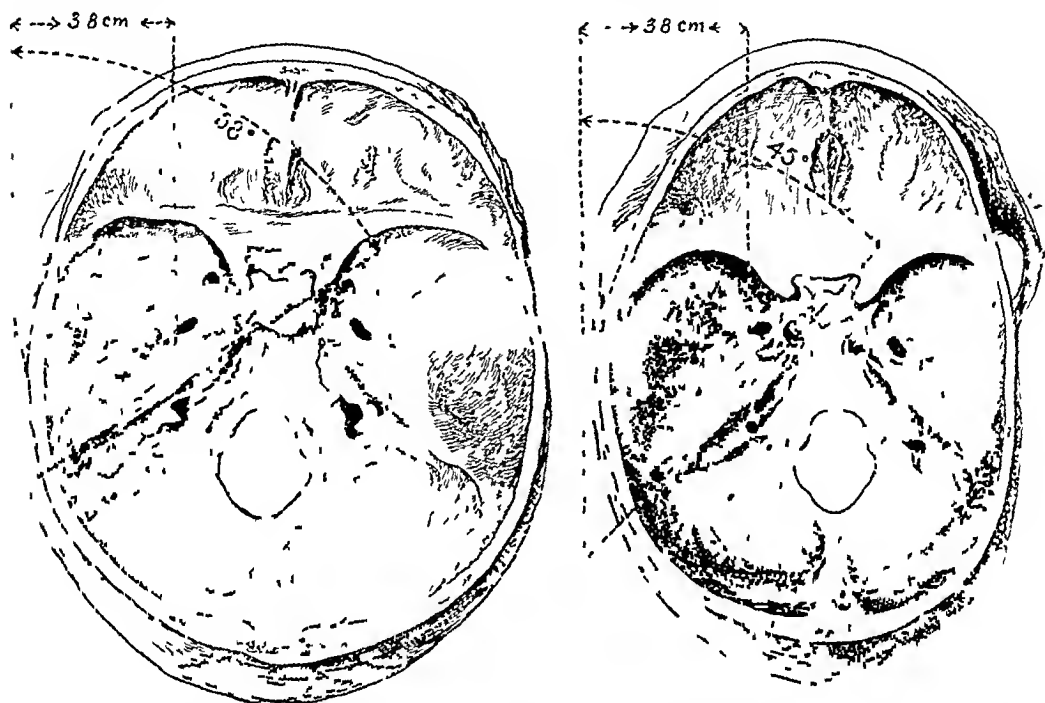


FIG 8—(A) Brachycephalic skull (B) Dolichocephalic skull. These illustrations are also drawn to scale from the same specimens as depicted above and illustrate the more acute angle of the petrous bone in the narrow skull (45 degrees) as compared with 58 degrees in the broad skull. However, the distance from the outer surface of the zygoma to the foramen ovale is identical in the two skulls (3.8 cm.)

slow and complete restoration of function may not occur until six months have elapsed.

Operative Questions—We have described the operative procedure in previous publications—the most recent in a contribution to *Surgery, Gynecology and Obstetrics* (now in press), therefore we shall not discuss the details here. We are convinced that our program of anaesthesia is the most acceptable. No doubt the operation can be performed under local or regional anaesthesia but in our experience the patient welcomes loss of consciousness. The patient has already suffered so much from the apprehension of pain that he or she dreads the thought of the ordeal of an operation if conscious of what is going on. So it is best to begin the operation under a general anaesthetic, ether preferred, which is not administered until one is ready to prepare the operative field and place the draperies. In a few minutes the patient is unconscious, the operation begun and as soon as the ganglion is reached, it is injected with 1 cc of 2 per cent solution of novocain. The ether is then discontinued, and before the patient regains consciousness the operation is concluded. Thus the advantage of a general anaesthetic with a

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minimum amount of ether. Speaking of injecting the ganglion, we have found it helpful should there be any oozing from the surface of the ganglion itself to inject into the ganglion, under pressure, normal saline solution. This has an immediate hæmostatic effect.

The approach to the ganglion may be made through a curved incision, which we have employed from the beginning, or through an oblique incision, but an important feature of either is a short horizontal limb parallel to and just above the zygoma. This gives width to the exposure where it is most needed, that is, at the base of the skull. We have continued to plug with cotton the foramen spinosum as the simplest way of controlling hemorrhage from the middle meningeal artery which with its accompanying vein must always be cut to give adequate access to the sensory root. The peripheral stumps of the vessels are clamped with silver clips at the conclusion of the operation.

The two essentials for an orderly, precise operation are proper illumination and control of bleeding. The former is provided by an illuminated retractor first employed in this clinic many years ago. The second essential is provided for with a suction apparatus which may be used not only for suction but, in approaching the ganglion, bluntly to separate dura from skull. More recently we have added to our armamentarium a septal elevator, which we use to separate the dura from the surface of the ganglion, that can be used also for suction. The combination is ideal and serves a most useful purpose when searching, as one must, for a line of cleavage between the dura mater and the dura propria, and when separating these two layers until the surface of the ganglion is exposed.

This operation was described in a popular text-book as "bloody, difficult and dangerous." Exception is well taken to the last qualifying term. Some operations are time-consuming and tedious rather than difficult, but none of the operations are "bloody", in the sense that there is massive bleeding. No doubt there were in the early operations on the ganglion when, judging from the literature of the day, the cavernous sinus was torn not infrequently. There is, of course, an extraordinary variation in the amount of troublesome oozing, in some cases almost none, in others constant oozing from many sources that may tax the operator's patience.

The essential features in the so-called radical operation for trigeminal neuralgia deals with the sensory root. To Spiller (Spiller and Keen, *Am J of Med Sciences*, November, 1898), credit is given as the first to propose section of the sensory root as a substitute for resection of the Gasserian ganglion. Prior to that, resection of the ganglion was the conventional radical operation, with only a few years before (1894) a mortality rate of 22.5 per cent. In 1901, the first deliberate section of the sensory root was performed in this clinic (*Philadelphia Medical Journal*, December 14, 1901 and October 25, 1902). Since that time the operation has been modified in certain essential particulars, notably in conservation of the motor root (1919),

and in conservation of a portion of the sensory root (1915) The significance of both in the welfare of the patient is obvious For the occasional case of bilateral neuralgia conservation of the motor root offers the only hope of relief This was demonstrated in this clinic in 1926 in the first case in which the major operation was performed on both sides (*J A M A*, November 20, 1926)

Conservation of a portion of the sensory root was first considered a feasible proposition and put into practice in 1915, and ten years later (*Arch Neurol and Psychiat*, March, 1925), a series of twenty-five cases was recorded in none of which throughout these ten years had there been a trophic keratitis The tremendous advantage of this to the patient is apparent When at a later period from our embryological studies we had a more accurate conception and more intimate knowledge of the structures of the sensory root and Gasserian ganglion, the principle of subtotal section of the root was extended to a wider field, so that today only that portion of the root is divided which conveys the afferent impulses from the pain area We are quite firmly convinced that, if pain is controlled or arrested in the zone in which the paroxysm is initiated, this will be all-sufficient In some cases, therefore, we have divided only that portion of the root which supplies the zone of the initial paroxysm That is in a case where the pain originates invariably in the third division, but extends to the territory of the second division, we have divided only the outer third or mandibular portion of the root But as a rule, especially in cases of long standing, we cut such portions of the root as correspond to the pain distribution Usually it is the middle and outer portions, that is the mandibular and maxillary, but it may be maxillary and ophthalmic, mandibular and ophthalmic Any combination is possible No one may question the absolute justification of conserving the ophthalmic division of the root, but why bother to conserve the mandibular or maxillary divisions? Because it reduces the area of post-operative anæsthesia While the true "tic" case is quite willing to exchange numbness for pain, this numbness will in some cases be a source of considerable annoyance and the more we can reduce the zone of anæsthesia, which in the first division includes an area as large as that of the other divisions combined, the better for the patient

After the Operation—In the twenty-five years covered by this survey, there has been a striking change in the minds of the doctors, as of the lay people Twenty-five years ago doctors told their patients, at least many of them did, that the radical operation was a kill or cure method It required not a little assurance to ease the patient's mind as to the freedom from risk compared with other operations But the profession knows now, and the patients too, that the mortality is a negligible factor I say patients because among the more intelligent often they have taken occasion to inform themselves of the nature of the operation, even to reading from the medical press In the last 269 consecutive operations for major trigeminal neuralgia, the mortality in this clinic has been 0.37 per cent We are not concerned now

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with the operative risks, but we do take certain precautions. A patient with a high blood pressure may be kept at rest for a week or two until the blood pressure falls as it does ten, twenty or thirty points with the patient at rest. A patient ill-nourished, dehydrated, exhausted because of fear of eating and long suffering, will be given an alcoholic injection so that he may have a brief respite from pain and some attention paid to his nutrition and fluid intake. With a patient over eighty years of age we may advise against operation as the risk may be great and the expectation of life short.

Anent the question of high blood pressure, we were once inclined to believe that the agonizing pain of trigeminal neuralgia might be a factor in the hypertension. We were inclined to this belief because we had seen a number of instances in which a high blood pressure, 180-220 Hg fell many points after the operation and continued at this level until discharge. Recently an inquiry has been made of the after history of this group, and where information is available we have found that in course of time the blood pressure has returned to its original pre-operative level.

But our chief concern is with the future of the patient. Before we learned the advantage of conserving the ophthalmic portion of the sensory root trophic keratitis was a troublesome complication. We know how often it developed before the patient left the hospital, but we made no great effort to ascertain what happened afterward. Happily, with the new technic, these days are over. As to the permanency of the cure there can be no question providing all the essential portion of the root has been cut. In these 511 cases there have been two recurrences. In one of these we operated a second time and found one fasciculus of the second division that had escaped. So that there is an immense satisfaction to the surgeon and a corresponding gratification on the part of the patient in the permanent relief afforded. The story of the after effects of the operation would not be faithfully told were mention not made of the patient, now and then, who having been robbed of paroxysmal attacks finds himself or herself possessed of certain paræsthesias which sometimes become an obsession and are magnified to the last degree. One patient may fear these sensations may be the forerunner of a recurrence and when assured the paroxysms cannot recur he is content. Another is seemingly unable to accommodate himself to these paræsthetic sensations and complains bitterly. Fortunately he is the exception to the general rule. Some day we may have a clearer understanding of these paræsthesias and of the discomforts of the atypical neuralgias. A fundamental study of the afferent system of impulses now under way may shed some light upon these perplexing phenomena.

RECURRING ULCERS FOLLOWING PARTIAL GASTRECTOMY

By DONALD C BALFOUR, M D

OF ROCHESTER, MINN

THE surgical treatment of peptic ulcer, in common with the surgical treatment of other chronic lesions, is not always followed by completely satisfactory results, nor are they necessarily permanent. In order to lessen the possibility of disappointing results, more radical surgical methods have been advocated, the most interesting of which has been partial gastrectomy. Although partial gastrectomy is usually the operation of choice for large perforated gastric ulcers, it does not appear to be a reasonable procedure for duodenal ulcers or for small gastric ulcers distant from the pylorus. In fact, removal of a large part of a normal stomach for the relief of a duodenal ulcer appears to be not only unnecessary but unwise.

In the earlier advocacy and performance of partial gastrectomy for duodenal ulcer the plea for such a radical procedure was based largely on physiologic grounds and little consideration was given to remote results. It is now clearly evident that partial gastrectomy for peptic ulcer, particularly duodenal ulcer, does not necessarily insure perfect digestion, nor does it necessarily protect the patient against subsequent ulceration. Several reports of recurring ulceration following partial gastrectomy have appeared, one of the most comprehensive being that of Birgfeld who classified fifty-three cases reviewed in the literature. This report is based on cases which have been seen in the Mayo Clinic.

All cases of recurring ulcer following partial gastrectomy were divided into three groups: (1) twenty-eight cases in which the ulcer was found at operation, (2) twenty cases in which a clinical or roentgenologic diagnosis (or both) of recurring ulcer was made, but chiefly because of mild symptoms the patients did not come to operation, and (3) five cases in which the subsequent course of the patient was either positive or very suggestive of recurring ulceration. The second and third groups are not considered in this report (Table I).

Of the twenty-eight cases in which operation was performed, fourteen followed resection for gastric ulcer, eight for persisting or reactivated duodenal ulcer following other operations, and six for gastrojejunal ulceration. Classifying these cases according to operation, three followed resection of the Billroth I type, six followed resection of the Billroth II type, ten followed sleeve resection, seven followed a Polya operation of the posterior end-to-side type, and two followed resection completed as an anterior end-to-side gastrojejunostomy (Tables II and III).

The cause of these recurrences cannot be established, since recurrence may take place when every known factor has been eliminated. The more important of these factors are: (1) hyperacidity, (2) operative trauma and technical

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errors, such as injudicious use of clamps, poor approximation of suture lines, and inadequate drainage, (3) gross indiscretions following operations, for example, excessive smoking, ingestion of indigestible foods, prolonged nervous tension, and marked irregularity in meals, and (4) foci of infection. Furthermore, the cause of recurring ulcer in the individual case is just as difficult to establish as the cause of the primary ulcer. The most conspicuous group is that composed of the so-called ulcer-bearing patients who are often energetic, driving persons who cannot adjust their mental and physical activities to the capacity of their nervous system.

TABLE I
Recurrence of Ulceration Following Partial Gastrectomy

Recurrence of ulceration	Cases
Found at operation at the Clinic	28
Diagnosed at the Clinic	20
Diagnosed or operated on elsewhere	5
Total	53

The symptoms of recurring ulcer parallel those of primary ulcer in one important respect: the pain, regardless of situation, radiation, or severity, is related to the ingestion of food. A full diet usually aggravates the pain, while bland food eaten frequently at least partially controls it. This effect of food is a fundamental point in the clinical diagnosis of recurring ulcer.

Pain may vary greatly in situation, radiation and intensity. It is usually diffuse and more to the left, and often radiates into the lower part of the abdomen, particularly to the left side. If it is relieved by normal bowel movement or by enema, involvement of the colon by an inflammatory process or by the ulcer itself is indicated. Pain radiating to the left shoulder in recurring ulcer is almost pathognomonic of perforation against the diaphragm. I have seen several cases with this complication. The pain may be so severe as to require opiates for control and if there is diaphragmatic involvement may simulate and be mistaken for primary diaphragmatic pleurisy. Loss of weight, anemia, and dehydration are commonly associated by reason of the inadequate amount of nourishment.

In this series of cases the chief complications of recurring ulcer following partial gastrectomy were perforation, hemorrhage, and obstruction. Perforation is frequently acute but is usually protected by the colon, omentum, diaphragm, spleen, pancreas, a loop of small intestine, or the abdominal wall. I have met with examples of all of these types. Usually, however, the perforation is subacute and the inflammatory process may be very extensive. The colon is commonly involved, in one case a large fistulous tract had opened into the colon giving the characteristic clinical and roentgenologic signs of gastrojejuno-colic fistula. The diaphragm may form the base of the ulcer. The inflammatory process may be so extensive as to form a palpable mass.

Hemorrhage is not uncommon, and may be either gross or microscopic, with varying degrees of secondary anemia. Obstruction is rarely marked, particularly if the Polya type of resection has been performed.

Fluoroscopic examination in these cases is of great aid in establishing the diagnosis. A roentgenologist skilled in interpreting the mechanics of the stomach and the gastro-intestinal anastomosis after various types of resection can, in a high percentage of cases, report with accuracy as to whether or not a lesion is present. In 55 per cent of these cases examination showed the free hydrochloric acid to be below normal, and in 26 per cent there was an absence of free hydrochloric acid.

The treatment of recurring ulcer following partial gastrectomy is usually surgical. Occasionally symptoms may be sufficiently controlled by less radical treatment, but more often they cannot be controlled and operation becomes necessary.

Pre-operative observation and preparation of patients is exceedingly important. The difficulties and risks of operation are definitely lessened by rest in bed, a bland diet, and the administration of large quantities of fluid.

TABLE II

Types of Lesion for Which Secondary Resection was Performed

Recurrence following partial gastrectomy for	Cases
Gastric ulcer	14
Duodenal ulcer	8
Gastrojejunal ulcer	6
Total	28

TABLE III

Types of Resection Followed by Recurrence of Ulceration

Procedure	Cases
Billroth I	3
Billroth II	6
Sleeve resection	10
Resection with posterior end-to-side gastrojejunostomy	7
Resection with anterior end-to-side gastrojejunostomy	2
Total	28

In the surgical treatment certain general principles should be observed. It is unwise to attempt a plastic operation, that is, removal of the ulcer and reconstruction of the anastomosis. It is also unwise to employ the same segment of jejunum that was used after the primary resection, so this segment is either resected or, if in good condition after the ulcer is excised, closed and a segment distal to the closure selected for the new anastomosis. The operation should be done either without clamps or with clamps so lightly

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applied that trauma will not result. All areas of obvious inflammatory change in either stomach or jejunum should be removed. The new anastomosis should hang free of the mesocolon and, if possible, a new type of gastro-intestinal anastomosis should be made. Finally, in the more intractable cases jejunostomy should be performed on the distal loop for the administration of nourishment and fluids during the first few days following operation. This not only is a factor of safety so far as the risk of operation is concerned, but it affords complete rest for the stomach and gastro-enteric anastomosis.

The selection of the best type of operation is governed by the type of the primary resection, the site of the ulcer, the extent of the inflammatory process, the involvement of other structures, and the condition of the patient. For recurrences following a Billroth I type of resection, posterior gastro-enterostomy should have first consideration since it may bring about complete relief. If this seems inadvisable, a reasonable amount of the stomach should be removed, that is, as far as the incisura, with closure of the duodenal stump and the reestablishment of gastro-intestinal continuity by a Polya operation or one of its modifications. For recurrences following segmental resections, a Polya operation, or a modification, is advisable. For recurrences following a Billroth II or a posterior Polya operation, the anastomosis is first mobilized, the mesocolon dissected free, the site of the ulcer identified and a segment of the stomach, the entire anastomosis, and enough of the jejunum to remove all obviously inflamed tissue, are resected. The jejunal defect is then repaired by end-to-end closure, and a new anastomosis made from the end of the stomach to the side of the jejunum distal to the closure of the latter. The mesocolon is then sutured to the stomach well above the anastomosis. In three cases, recently, in which the jejunal loop was resected I made a Roux type of anastomosis: in one case I closed the end of the distal jejunal loop, doing an end-to-side (stomach to jejunum) anastomosis, then implanting the end of the short proximal portion of the jejunum into the distal loop about 5 cm. below the gastro-enteric union, in the two others I closed about two-thirds of the end of the stomach, implanted the end of the distal portion of the jejunum into the remaining opening, and anastomosed the end of the proximal jejunal loop into the side of the distal portion of the jejunum below the gastro-enteric anastomosis. In all of these a jejunostomy tube was used. The patients have been completely relieved of symptoms, free hydrochloric acid has been absent on repeated examination, and the stomach apparently was functioning normally. Such a method at least has the advantage that any ulceration that may occur in the future is more easily dealt with than if the entire end of the stomach is used.

Should ulceration recur in these cases further tissue may be resected and a new end-to-side anastomosis made. The anterior end-to-side anastomosis, although seldom employed for ulcer, has the advantage that it is much more easily dealt with than a posterior anastomosis in case a secondary operation is necessary.

The site of the ulcer determines, to some extent, the type of the operation

Ulcers entirely in the jejunum, if on the mesenteric side or in the distal loop, are either excised or the segment of jejunum is resected. If the ulcer is in the proximal loop of the jejunum and almost inaccessible because of a short loop, there is at least a fair chance that the lesion will heal if the new anastomosis is made 7 or 8 cm distal to it. In some cases the ulcer is so awkwardly situated and the inflammatory process so extensive and so acute that temporary jejunostomy to permit the inflammation to subside is an excellent procedure. In a case in which I recently employed this method the patient has been completely relieved of pain and it appears that the ulcer has healed. Such a possibility should always be kept in mind in recurring ulceration, just as in primary ulceration.

Involvement of the colon in the inflammatory process should be dealt with after the entire anastomosis has been mobilized. After the colon has been dissected free, it is frequently found that its wall forms the base of the ulcer. This base is curetted, iodized and plugged with surrounding omental tags. If a fistula is present the fistulous opening is closed with chromic catgut, reinforced with silk, extra precautions being taken in wrapping the area with omentum.

If perforation against the diaphragm has occurred, the attachment is separated and the area on the diaphragm sterilized with iodine.

Finally, the condition of the patient is a factor in determining the type of operation, but anything but a radical operation is seldom necessary or advisable. The best alternative to such a procedure is jejunostomy.

The results of operation in these cases of recurrent ulcer after partial gastrectomy show the presence of a very intractable disease. As McVicar says "There are outlaws in a surgical sense, just as there are outlaws in a social sense." Again it should be emphasized that partial gastrectomy as a primary operation for benign peptic ulcers does not afford absolute assurance that ulceration will not recur, and if such recurrence does take place, the difficulties of any further surgical procedures are often exceedingly great and the results none too satisfactory.

DISCUSSION DR ARTHUR D BEVAN, of Chicago, Ill., said that in the last ten years surgeons have been led to believe by the work of Haberer and Finsterer and other German surgeons, and by Moynihan, in England, that in handling peptic ulcer a solution had been found very much better than gastro-enterostomy, and that is by actually resecting the ulcer, removing it. And they have led us to believe that recurrence of ulcer after stomach resection was extremely rare. Now, when Doctor Balfour reports that some fifty-three cases have been studied, found either in their own clinic, or in cases coming to the Mayo Clinic, from other surgeons, in which recurrence of ulcer after resections has been found, it puts a very different light upon the whole subject. It shows at once that even resection is not always a permanent cure of peptic ulcer.

He personally had never felt that it was. He had always felt that peptic ulcer was due to the action of certain very definite causes which might per-

RECURRING ULCERS FOLLOWING PARTIAL GASTRECTOMY

sist after the occurrence of a first ulcer and its complete removal and result in the production of a new ulcer or ulcers

From the time of Cruveilhier and Rokitansky we have had the conception that peptic ulcer, as its name implies, is due to the corrosive action of the gastric juice upon a damaged piece of stomach wall. He had been glad to find that in the elaborate work of Hauser which is published in the Henke-Lubarsch system of pathologic anatomy and histology, Hauser takes quite definitely that same simple position

Now, of course, even after a resection we may have conditions in the stomach in which an ulcer may recur from the digestion of a piece of damaged wall, damaged usually from some vessel lesion. It is true that after a resection, especially a resection which has removed the *magenstrasse*, we have removed the most vulnerable part of the stomach. If we resect largely the lesser curvature extending from the oesophagus to the pylorus, we certainly have removed the most vulnerable part of the stomach, and we are not as apt to have recurrence if that part is removed. But that recurrences do occur is absolutely true. That fact is a very important thing in evaluating this whole large problem, to decide the question as to whether we should handle a case medically or surgically, to recognize the fact that a resection, no matter how wide, is not always a permanent cure.

One of our German colleagues made this statement in regard to a case in which repeated resections of the stomach had been made, four, I think, in number. He said, "Yes, if you have an ulcer of the leg, if you amputate the entire limb, you will have no further ulcers on that leg."

DR HERBERT ALEXANDER BRUCE, of Toronto, Canada, said that two years ago he attended the meeting of the British Medical Association when Finsterer gave a paper on gastrectomy for peptic ulcer, in which he advocated in all cases the removal of the stomach for this condition. He reported one case just as Doctor Balfour has to-day, in which recurrence had followed gastrectomy, necessitating three subsequent operations. In other words, although he had removed a large portion of the stomach for peptic ulcer, recurrence of the ulceration had followed this operation and two subsequent operations.

Mr. Patterson preferred the operation of gastro-enterostomy for the relief of peptic ulcer, and the majority of the surgeons who were there agreed that as it is the simpler and safer operation, and has been attended by such excellent results that it should be the operation of choice. There are a few cases undoubtedly in which a gastrectomy is desirable and indeed necessary to effect a cure, but the pendulum is swinging too far in the direction of gastrectomy for the relief of all peptic ulcers, and therefore this paper of Doctor Balfour's to-day is welcome as showing that even gastrectomy does not necessarily cure all peptic ulcers.

CANCER OF THE STOMACH IN PATIENTS OVER SEVENTY YEARS OF AGE

BY J. SHELTON HORSLEY, M.D.

OF RICHMOND, VA.

THE frontiers of old age are being pushed forward. With the prolongation of life the outer limits of middle age extend and old age is now putting in its appearance later and later.



FIG. 1.—Anterior view of specimen consisting of the right portion of the stomach of patient, Mr. J. H., seventy-seven years of age. On the right is the duodenum. There is one soft polyp and another smaller one within the grasp of the pyloric sphincter. In the mucosa adjoining is a superficial moth-eaten type of ulcer. It is soft, apparently hardly penetrating to the muscular coat. Both the polyp and the ulcer proved to be a highly malignant type of cancer. (Case III.)

Probably we can agree, however, that a patient is beginning to get old at seventy, and at this age certain changes usually have occurred. No machine or organism can work for seventy years without some traces of wear and tear that necessarily affect to some extent the functional processes.

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In treating diseases in the old often principles of treatment that are applicable in younger patients must be modified. For example, general anæsthesia that may be well borne in vigorous youth or in middle age may not be tolerated in a patient over seventy. Even the production of unconsciousness in the aged without any operation, particularly if for a prolonged time, is sometimes followed by cerebral disturbances or by an upset of the stomach, the kidneys or the lungs. Narcotic drugs are more dangerous in the old.

One of the well-known lesions that appears more frequently with increasing age is cancer, and the most important structure concerned with the metastasis of cancer is the lymphatic system. In the old the function of this system diminishes. The lymph-nodes rarely become enlarged unless from some marked stimulus, and the lymph vessels transmit but feebly. This tends to retard the metastases of cancer and gives more hope of cure from a radical operation in the aged than in those with a more vigorous lymphatic system.

No one is immortal, relief or cure is relative. An operation that saves a patient from the fatal effects of a gangrenous appendix at twenty and permits him to die of apoplexy at seventy merely prolongs his life for fifty years. It would seem, then, that if there is a reasonable chance of marked relief for a period of at least a few months with even a slight prospect of cure, the fact that the patient happens to be over seventy should not be a contra-indication to operation.

During the past two and a half years I have done a partial gastrectomy for cancer on five patients over seventy years of age. While the technic of this operation was not altered from that which I have used for four years, and which has been published in detail elsewhere,¹ it seems to be particularly applicable in these cases. It is a modification of the Billroth I operation. With the natural relaxation of the tissues in these patients there is no difficulty in approximating the stump of the stomach to the duodenum. In the Polya operation the jejunum must be brought either over or under the transverse colon, so this additional field of manipulation is avoided. The operation consists in the union of the upper end of the stump of the stomach to the stump of the duodenum, flared open by making an incision into its anterior wall for about one and a quarter inches after the first row of sutures has been placed between the stump of the stomach and the stump of the duodenum, to fix the physiologic position of the lesser curvature. The researches of Alvarez, Klein, and others have shown the importance of the lesser curvature. It contains neuro-muscular structure, which initiates peristalsis, and the main centre for this is near the œsophagus. Klein thinks



FIG. 2.—View of pyloric end of the stomach before the specimen was opened, showing the polyp protruding through the pyloric sphincter.



FIG 3.—Case of Mr J J H. Photomicrograph of polyp of the stomach seen in two preceding figures. In some regions there is an attempt at venous formation, but in most of the field the cells are markedly undifferentiated. It is classed as a carcinoma grade 1 (X 150)



FIG 4.—Section from the margin of the superficial ulcer in the gastric mucosa shown in Fig 1. Showing leukocytic infiltration of the deeper tissues and circumferential change throughout most of the mucosa. In the centre is a lymph follicle around which there is moderate infiltration (X 50)

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there is a secondary centre near the incisura. The incision in the duodenum prevents constriction which sometimes occurs if the thick wall of the stomach is sutured to the end of the thin wall of the duodenum. After this partial gastrectomy the gastric contents enter the duodenum and can be immediately subjected to the action of its circular fibres, so normal peristalsis may begin at once. By flaring open the duodenum an end-to-end union can sometimes be made, but if not, a purse-string suture easily turns in the redundant tissue at the lower end of the stump of the stomach, and this is reinforced by bringing over the adjacent peritoneal covered fat.

This operation, then, admits of wide excision of the cancerous area, of ample approximation of the stump of the duodenum to the stump of the stomach, and at the same time limits the field of procedure to the region of the excised portion of the stomach.

The anæsthesia has already been mentioned. Local anæsthesia was used in the five cases here reported. The method consists in infiltrating the site of the proposed abdominal incision and to some extent blocking off the region of the incision by inserting the novocain solution several inches from it. After the abdomen is opened and the cavity is gently explored the anæsthetic solution is introduced in the retroperitoneal tissues above the head and body of the pancreas, and then to the left toward the body of the vertebræ above the pancreas. Other retroperitoneal tissues, as along the root of the transverse mesocolon, are infiltrated, and if the patient complains of pain on traction, infiltration of the tissues as high up on the left side along the vertebral column as possible and in the retroperitoneal tissues above the head of the pancreas is again done. The anæsthetic used is 0.5 per cent novocain in which about three drops of adrenalin solution is added to every ounce of the mixture. This is made in freshly distilled water to which tablets have been added to make it a standard Ringer's solution.



FIG 5—Higher magnification of a portion of the previous photomicrograph. Just above the lymph follicle is the carcinomatous mucosa ($\times 150$).

CASE I—Mr C. L. W., white, retired druggist, seventy-one years of age, admitted to hospital, December 27, 1925. He was much emaciated. For two or three months before admission to the hospital there was a dull pain in the upper abdomen, coming on after eating. The pain was intermittent in character with slight nausea and occasional vomiting. There was considerable abdominal distention. There had been no

hæmatemesis or blood by bowel Operation, December 29, 1925 In all of these five cases the partial gastrectomy that has been described was done The stomach was somewhat distended, though it had been washed out about an hour before the operation On removing the Payr clamp on the stomach it was found that the stump of the stomach was filled with semisolid and solid material which could not pass through the stomach tube It was necessary to scoop out this with the hand After cleaning the stomach as thoroughly as possible the clamp on the duodenum was removed and the operation was completed in the usual way The operation lasted two hours and fifteen minutes The pulse was 72 at the beginning of the operation, and 80 at the end

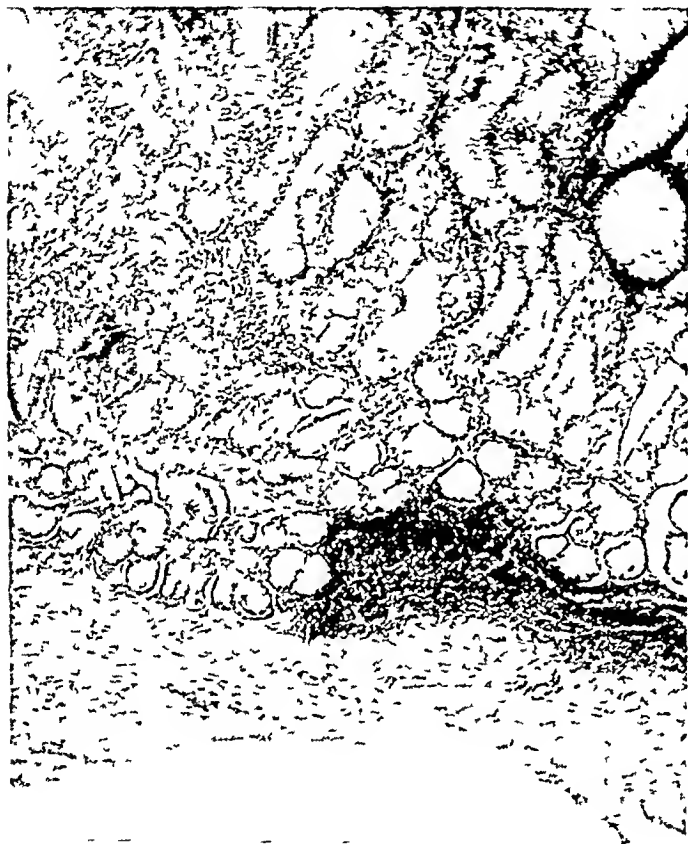


FIG 6—Section from the cardiac margin of the specimen showing the mucosa practically normal, without carcinomatous change but with moderate leukocytic infiltration ($\times 75$)

The specimen, consisting of the pyloric end of the stomach, measured along the greater curvature 23.5 cm, and along the lesser curvature 11.5 cm There was an infiltrating growth in the anterior wall of the stomach adjoining the pylorus and along the lesser and greater borders of the stomach there were a few enlarged firm lymph-nodes Internally there was an ulcer with raised everted margins and the stomach wall was thickened, producing almost complete obstruction Microscopic examination showed adenocarcinoma of moderate malignancy

The patient made a very smooth recovery, there being merely a superficial infection in the skin wound The pulse rate never exceeded 100, nor the temperature 99.8 He was discharged on January 29, 1926, with a temperature of 98.4, pulse 76

He gained in weight and was in good health until in October, 1926, when he complained somewhat of occasional attacks of dizziness This apparently did not annoy him seriously, but early in 1927 he began having some gastric symptoms On May 24, 1927, examination showed a rather firm mass beneath the abdominal scar The mass was slightly movable and seemed to be attached to the stump of the stomach The liver was not enlarged The patient's general condition was fairly good In view of these things and of the fact that histologically the tumor was not very malignant, even though it was rather extensive, further operation was advised but was declined The patient gradually grew worse, and died October 29, 1927, nearly two years from the date of operation

CASE II—Mr B C M, farmer, white, admitted to the hospital, May 24, 1926, complaining of "stomach trouble" For the last fifty years he had been subject to "indigestion," and was relieved only by an ulcer diet He was emaciated, and had lost about fifteen pounds in weight in the past six months For seven months he had had epigastric pain with nausea The pain was constant, with no definite relation to meals The nausea increased after taking food Röntgenologic examination showed a large filling

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defect in the pylorus. A partial gastrectomy was done May 28, 1926. The operation lasted two hours and thirty minutes. His pulse was 90 at the beginning of the operation, and 70 at the end.

The specimen consisted of the pyloric end of the stomach measuring 17.5 cm along the greater curvature and 11.5 cm along the lesser curvature. Along the greater and lesser curvatures were enlarged lymph-nodes. On the lesser curvature they extended



FIG 7.—The anterior view of the right half of the stomach removed from Mr. F. C., seventy years of age. The growth infiltrated the entire wall and involved the round ligament of the liver. There are several large lymph nodes along the greater curvature. (Case IV.)

almost to the end of the specimen. Most of them were firm and appeared to be metastases. There was an excavating ulcer with everted margins. The sections showed adenocarcinoma of considerable malignancy, about grade 3.

The patient developed pneumonia and on this account had a somewhat stormy convalescence though the operative wound healed well. He left the hospital June 22, 1926, in good condition, with a pulse of 60 and temperature 98.

He improved and was in good health until early in November, 1926, when he had pain in the epigastrium. Food seemed to accentuate the pain and caused a slight nausea. Röntgenologic examination at this time showed that the stomach was apparently functioning normally except for rather rapid emptying. No evidence of recurrence of the cancer in the stomach was found. Physical examination showed distended veins over the upper abdomen and some tenderness over the liver region. No definite masses could be felt. The patient died March 21, 1927. There was a history of increasing discomfort in the upper abdomen with probably enlargement of the liver. There was no necropsy, but death seemed to be due to metastasis in the liver.

CASE III—Mr. J. J. H., white, age seventy-seven, farmer, entered the hospital, February 8, 1927, complaining of indigestion, nausea and vomiting. He was markedly emaciated and had lost about forty pounds in weight in the past two years. About

two years before admission he had suffered periodic attacks in which food seemed to "sour on the stomach." These symptoms were relieved by vomiting. He had vomited no blood, and none was passed by the bowel. He was sometimes free from symptoms. Rontgenologic examination showed almost complete obstruction at the pylorus.

A partial gastrectomy was done February 10, 1927. The stomach was markedly dilated, but the peritoneal covered surface seemed normal. There was an indefinite



FIG 8—Posterior view of the specimen shown in the preceding figure. Note the attached mesocolon which was adherent to the cancerous mass and was resected with it.

soft mass about the pylorus, but there was no induration. The lymph-nodes were apparently not involved. The stomach was greatly distended. There was a quantity of solid material in the stomach, and as in Case I it was scooped out with the hand. The operation lasted two hours. The pulse was 60 at the beginning of the operation, and 66 at the end.

The specimen, consisting of the pyloric portion of the stomach, measured 12.5 cm along the greater curvature and 8 cm along the lesser curvature. Externally the peritoneum seemed smooth and presented no evidence of infiltration. On the mucous

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surface there were superficial ulcerations in the pyloric mucosa (Fig 1) Projecting into the pyloric sphincter from the stomach was a small polyp-like growth (Fig 2) There was evidence of marked gastritis There was a small mass in the gastro-hepatic omentum along the lesser curvature which on incision contained thick yellowish fatty material with no evidence of malignancy The ulceration in the pyloric mucosa was irregular in contour, and apparently did not extend through the whole depth of the

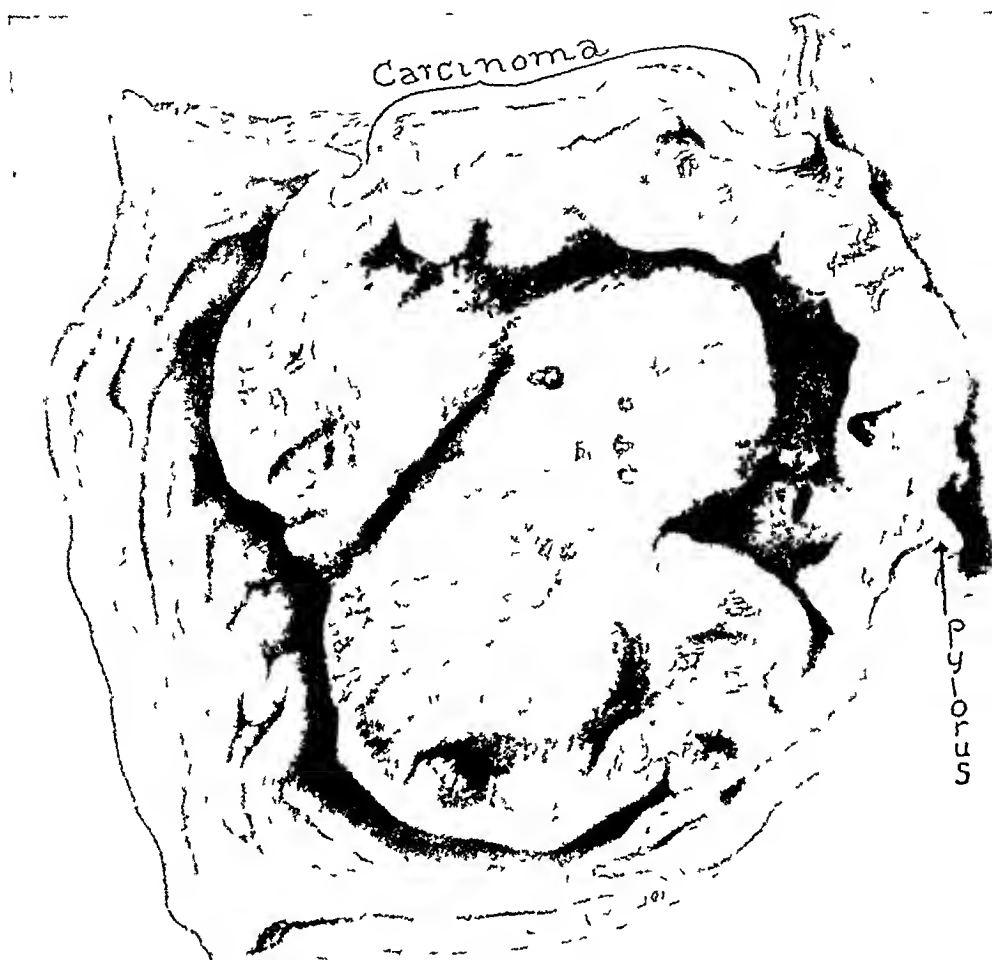


FIG 9—The interior of specimen shown in the preceding two figures There was a large ulcerating carcinomatous mass with sharply marked margins which were firm

mucosa Sections both from the polyp and from the margin of the ulcerated area showed carcinoma of a high degree of malignancy A specimen submitted to A C Broders, of the Mayo Clinic, was graded by him as 4 (Figs 3, 4, 5 and 6)

The patient made a smooth operative recovery, his pulse never exceeding 96 He was discharged on March 4, 1927, in excellent condition, with pulse 80 and temperature about 98

He was greatly relieved by the operation, and for several months his health was excellent He developed nephritis, however, and died October 26, 1927, of nephritis There was no necropsy, but there was no clinical evidence of a recurrence of the cancer

CASE IV—Mr F C, white, age seventy, farmer, was admitted to the hospital on March 31, 1927, complaining of a "lump in the stomach" He was emaciated, and had lost twenty pounds in weight in the past three months The present illness began about three months before admission with loss of appetite and weakness Pain developed about

three weeks before admission. There was no nausea or vomiting, and the patient had apparently passed no blood by bowel. Rontgenologic examination showed a large filling defect in the pyloric portion of the stomach.

April 5, 1927, a partial gastrectomy was done. The growth was quite extensive. It had invaded the round ligament of the liver anteriorly and some of the mesocolon posteriorly. There were a few enlarged lymph-nodes on the greater curvature, but none appeared on the lesser curvature. The liver seemed normal. The round ligament was divided with the electric cautery. A portion of the mesocolon which was adherent

posteriorly was also removed with the stomach. This impaired the circulation to the transverse colon, so part of the transverse colon was excised and union was made end-to-end according to the technic of Kerr. The operation lasted two hours and thirty minutes. The pulse was 70 at the beginning of the operation and 78 at the end.

The specimen consisted of the pyloric end of the stomach and a part of the transverse colon. The specimen of the stomach measured 14 cm at the greater curvature and 9.5 cm at the lesser curvature. There was a lymph-node along the greater curvature near the duodenum which was 3.25 cm in diameter. Both the anterior and posterior walls of the stomach were



FIG. 10.—Photomicrograph from specimen in the preceding three figures. The histology is that of adenocarcinoma in which the cells are fairly well differentiated and shows histologically a mild degree of malignancy ($\times 150$).

extensively invaded. Anteriorly there was attached a portion of the round ligament of the liver 10 cm long which had been severed with the electric cautery (Fig 7). Posteriorly there was attached a portion of the mesocolon (Fig 8). Besides the large lymph-node there were several smaller lymph-nodes along the greater curvature, and none along the lesser curvature. Internally the growth showed an excavating ulcer with everted margins (Fig 9). The specimen of the colon appeared to be normal. It was removed because of interference with its nutrition. Microscopic section showed adenocarcinoma of the stomach of a rather mild degree of malignancy (Fig 10).

The patient made a fairly satisfactory recovery except that infection appeared in the abdominal wound, and a fecal fistula developed from the transverse colon. A slough was eventually discharged and the fistulous opening closed. He left the hospital on May 5, 1927, with pulse 70 and temperature 98.

On February 6, 1928, he returned for examination. Until a few weeks before this time his health seemed to have been good. Examination showed a mass in the upper right quadrant of the abdomen which appeared to be an enlargement of the liver. It was smooth and extended to just above the navel. The patient's general condition appeared fairly good. There is evidently metastasis in the liver. The patient was living when last heard from, but of course the outcome will be fatal.

CASE V—C. B., male, white, age seventy-five, farmer, entered the hospital on

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May 24, 1927, complaining of "stomach trouble" He was much emaciated and his arteries were markedly sclerotic He had lost fifteen pounds in weight during the past year The illness began about a year before admission, with pain in the pit of the stomach which was increased by eating coarse foods and meats He was free from symptoms while the stomach was empty Light foods did not cause pain He had not vomited nor passed blood by bowel He suffered somewhat from nausea

May 27, 1927, a partial gastrectomy was done The disease was quite extensive, though his stomach was fairly movable There were enlarged lymph-nodes along the lesser and the greater curvatures After removing the stomach it was found that a suture, where a part of the mesocolon adherent to the stomach had been removed, involved some of the vessels in the mesocolon The transverse colon, however, seemed to have a feeble circulation, and it was not resected The operation lasted two hours The pulse was 60 at the beginning of the operation, and 70 at the end

The specimen consisted of the pyloric portion of the stomach which measured 13 cm along the greater curvature and 12 cm along the lesser There was an infiltrating mass in the anterior wall of the stomach There were several enlarged lymph-nodes along the greater curvature, and a few small lymph-nodes on the lesser curvature Most of the lymph-nodes on section showed that they contained adenocarcinoma There was in the large infiltrating mass in the anterior wall of the stomach a shallow ulcer which was about 4 cm in diameter The margins were firm and raised Microscopic section showed adenocarcinoma of moderate malignancy

The patient did well for six days, then his temperature rose to 102 and pulse to 110 The wound was infected Under local anæsthesia the wound was opened and it was found that the transverse colon was gangrenous for about 5 cm It was resected and an end-to-end union was made There followed gangrene in the abdominal wound Much of the skin and fat sloughed away The sutures in the transverse colon broke down and a full fecal fistula resulted There seemed to be but little effort to heal The patient died of exhaustion on June 28, 1927 Apparently the wound in the stomach healed satisfactorily but a short while before he died a small gastric fistula occurred

The chief error in this case was in not resecting the transverse colon at the time of the partial gastrectomy, as had been done in the previous patient

SUMMARY

Of these five patients, all men, the oldest was seventy-seven years, the youngest seventy, the average age was seventy-three After a rather long operation no patient left the table with a pulse rate over 80, the average pulse rate on leaving the table for the group being 73

In four of these cases there was very advanced carcinoma In two of these four it was necessary to resect the transverse colon, and in one of the cases in which the transverse colon was resected some of the round ligament of the liver was also removed

In Case II and in Case III the history is suggestive of a previous benign lesion in the stomach as an etiologic factor in the cancer In the other three cases the cancer apparently arose without any history of preceding "stomach trouble"

In Case III, though the cancer was not advanced, the histologic structure showed a high degree of malignancy This patient lived for several months in comfort and died eight and a half months after the operation from an intercurrent disease

Of the three other patients surviving the operation, one died about two

years after operation having had sixteen months of good health. Another patient is living with a metastasis in the liver, thirteen months after the operation. Another died ten months after operation, having been in good health for five months.

While the results cannot be said to be brilliant, each of the four patients that survived the operation had several months of good health. When the advanced stage of the disease, the age of the patients and the necessary extent of the operation are considered, it would seem that under the circumstances the relief obtained justified the procedure.

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DISCUSSION. DR. EMMET RIXFORD, of San Francisco, Calif., said that he supposed that just because the patients are elderly the type of malignancy is less vicious than in younger people, and that the tumor is more apt to occur at the pylorus where it produces early symptoms and therefore is more favorable for excision than in carcinoma in younger people and in other parts of the stomach.

He recalled the case of an old lady of seventy-one who was ready to die of starvation, had had no food for six weeks except by rectum, but refused operation. Her family finally insisted that something be done. The pylorus was removed. It was as pretty a case as one could wish for, of a tiny tumor that caused complete obstruction. She made an uninterrupted recovery, and at the age of seventy-eight blew up with intestinal distention from a new carcinoma of the sigmoid. It may not have been new, but it was at least another carcinoma. This was removed, and the patient likewise made a good recovery and went into an old ladies' home, passed her ninetieth birthday and was not very far from a hundred when she finally died from something other than carcinoma.

PYLORIC ACHALASIA AND PEPTIC ULCER

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AND

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ACHALASIA is the term applied by Hurst to persistent failure of a sphincter to open widely in response to that coordinating mechanism by which visceral contents are intermittently retained and propelled

In this paper pyloric achalasia is arraigned, as a cause of chronic dyspepsia, of ulcer symptoms in the absence of ulcer, as a contributing factor in the development of peptic ulcer, and as an underlying reason for its chronicity

The pyloric sphincter, five or six millimetres wide and a quarter as thick, is shown by dissection as a distinct anatomical and by function as a distinct physiological entity. If relaxed it may not be palpable as such in the open abdomen, but its position is marked by its short stubby transverse veins, and when contracted, it and the region of the pyloric canal may be both seen and felt as a blanched nodule. Its blood comes from the pyloric branch of the hepatic artery.

The sphincter receives sympathetic and parasympathetic (vagus) fibres, the latter ending about local ganglionic cells and the weight of evidence from clinical and experimental results indicates that the former are for contraction and the latter for relaxation.

Concerning the nervous control of the pylorus there is some dispute between those who hold that vagus influence is for contraction and sympathetic for relaxation and those who maintain the reverse of this theory. Hughson supports Latarjet's belief and concludes from his experiments on dogs that vagal stimulation causes contraction of the pylorus and that reflex pylorospasm is prevented by section of the vagus. Thomas and Wheldon contend that the pylorus is not a separate functional entity with a special nerve supply, that it has a double innervation consisting of motor and inhibitory nerves by way of the vagi and splanchnics, both nerves being mainly motor. May says that the splanchnics have no direct influence either motor or inhibitory on the musculature of the stomach and that vagal stimulation causes first inhibitory and then augmentor effects on both the musculature of stomach and on the cardiac and pyloric sphincters. In experiments on the pylorus it has been difficult to distinguish between purely vagal and purely sympathetic effects, since the nerves in this region contain fibres of both types. According to Gaskell's studies on the involuntary nervous system all sphincters receive their contractile nerves from the sympathetic system and their inhibitory nerves from the parasympathetic system, the vagus nerve belonging to the latter system. Elliott proved that the ileocaecal sphincter conforms to this plan. Nakanishi showed in the rat that the main effect of the vagus on the pyloric sphincter is inhibition and that of the sympathetic is contraction and also that adrenalin causes the same effect as sympathetic stimulation. Schaffer produced spasm of the pylorus by injection of adrenalin into the

suprarenal vein Klee and Koennecke produced contraction of the pylorus by sympathetic stimulation In his clinical studies Fraser favors the views of Gaskell Pirie believes that hyperadrenalism may be a cause of pyloric hypertrophy and stenosis of infancy

Pyloric achalasia meaning failure of inhibition by which the sphincter remains closed but not spastic is the result of disturbed correlation between sympathetic and parasympathetic control Such disturbances may be caused

by preponderance of sympathetic influence or by partial or complete paralysis of parasympathetic or vagal fibres

The normal mechanism of the pylorus seems to have little to do with the emptying time of the stomach since Alvarez has shown that gastric waves often seem to fade away or get reversed just before reaching the sphincter so that many human stomachs fail to empty properly in spite of good peristalsis and a patent pylorus Achalasia and spasm of the pyloric sphincter may cause some degree of gastric retention but



FIG 1—Location of pyloric sphincter at distal end of stomach marked by short transverse veins

will not completely withstand the peristaltic push so that emptying, although delayed, is finally accomplished by hypermotility Such delay prolongs the action of hydrochloric acid in the stomach and has been shown to be an important factor in retarding the healing of experimentally produced gastric ulcers

An important function of the pyloric sphincter has to do with the control of duodenal regurgitation which is a natural phenomenon occurring during both the digestive and interdigestive phases Boldyreff's work which has been confirmed by many others showed that the gastric juice which when formed contains 0.5 per cent hydrochloric acid is later reduced for purposes of digestion to 0.15 to 0.2 per cent, the equivalent of a titration of 45 to 55 decinormal sodium hydroxide Attention may be called here to the fallacy of attaching pathologic significance to high acid values obtained by the usual

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method of gastric analysis. Equally high acid titrations have been obtained in normal stomachs as have ever been recorded in gastric or duodenal disease. The maximal strength (0.5 per cent) of acid is secreted by the normal stomach so that the titer value will depend on the degree of neutralization which obtains when the sample for analysis is removed. The regulation and reduction of gastric acidity to an optimal level is accomplished by the regurgitation of alkaline juices, principally pancreatic juice, from the duodenum. During normal diges-

tion, duodenal regurgitation begins at the peak of the curve of free hydrochloric acid and this process of neutralization continues as the rising curve of the inorganic chlorides crosses the falling curve of the free acid. Thus the curve of the inorganic chlorides becomes the index of duodenal regurgitation. Therefore the varying values of gastric acidity depend upon the efficiency of duodenal regurgitation over which the pyloric sphincter exerts the main controlling influence. Under normal conditions the sphincter maintains a nicely balanced gastro-duodenal correlation but when it is affected by achalasia or spasm it may partially or completely prevent regurgitation into the stomach, and thereby cause hyperchlorhydria by preventing neutralization of the newly formed hydrochloric acid. Because of the difference in force between gastric peristalsis and duodenal regurgitation, the latter may be markedly disturbed by achalasia or spasm of the sphincter although there may be no significant delay in the emptying of the stomach.

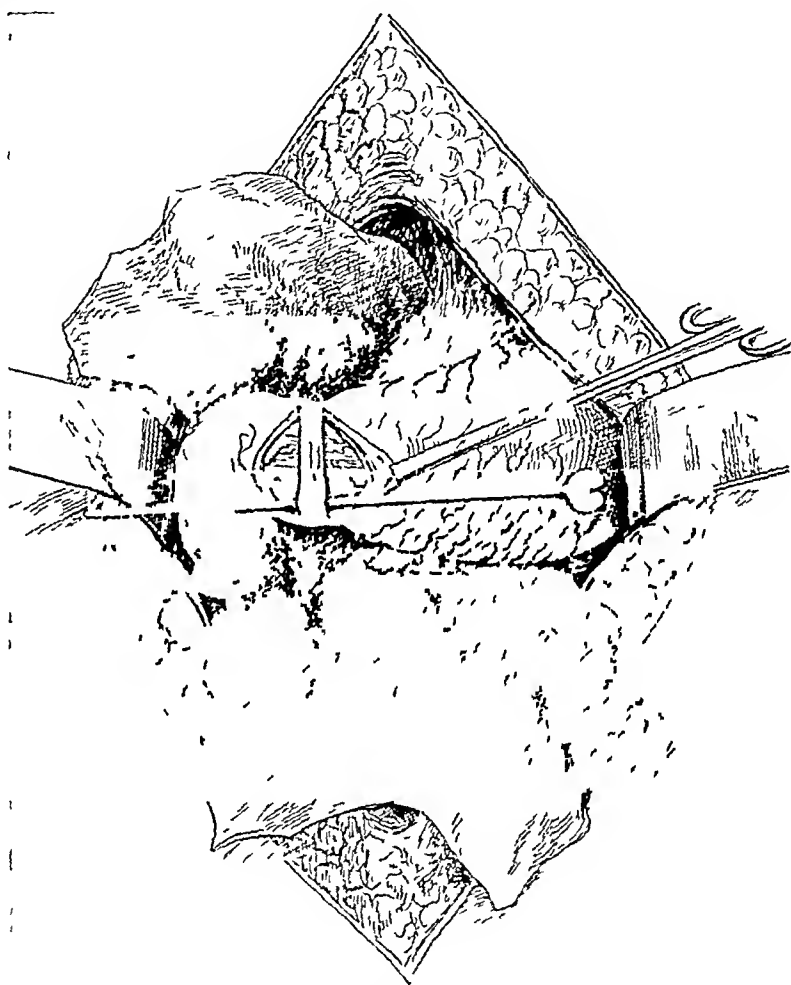


FIG. 2.—Anterior half of sphincter prepared for removal by two elliptical incisions through outer coats of stomach and duodenum, showing the unopened underlying submucosa.

Bolton has called attention to the importance of pyloric tone in the regulation of gastric acidity and he believes that hydrochloric acid is the agent mainly responsible for the maintenance of peptic ulcer. It is well known that gastric analysis in some cases of ulcer reveals normal values and that very

high acidity may occur in the absence of ulcer and without symptoms. Gastric analysis affords us very little insight into the chemical workings of the stomach, and practically no information regarding the properties of the material which passes through the pylorus, both during digestion and when the stomach is empty of food. The strength of acid impinging on the first portion of the duodenum is the important factor in the development of ulcer. Beyond this point excessive acid is quickly neutralized so that ulcer in the lower duo-

denum is almost unknown. The strength of acid which is ejected through the pylorus against the duodenal cap is determined by the degree of neutralization in the stomach which in turn is dependent upon duodenal regurgitation.

The strategic position occupied by the pyloric sphincter imparts to it potential powers of mischief for the well-being of both the stomach and duodenum. Its irritability and sensitiveness to reflex stimuli are registered by an increased tonus or failure of normal relaxation. Such dis-



FIG 3—Anterior half of sphincter being removed from the underlying submucosa

turbance of function gives rise to changes in the chemistry of the stomach and in the nature of the material which continually strikes the first portion of the duodenum. There are various sources for these reflex stimuli, the most common being lesions in other abdominal viscera. The initial symptoms of most inflammatory lesions of the abdomen are manifested by gastric disturbance which can be accounted for by abnormal behavior of the pyloric sphincter. The symptoms in chronic cases of extra gastric disease often lead the unwary diagnostician to suspect disease of the stomach. Hughson showed that pylorospasm often follows a simple incision of the peritoneum. In surgical experience appendicitis and cholecystitis are the most frequent causes of pyloric disturbance. The roentgenologist often demonstrates it

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The irritability of the pyloric sphincter is responsive to stimuli emanating from the central nervous system which may be the result of various irritations both mental and physical. It is characteristic of the symptoms of peptic ulcer to be initiated and accentuated by mental worry and strain. That many individuals with ulcer have an inherent tendency toward this type of nervous gastric instability is recognized by those who deal with many cases of ulcer, and to it has been attributed in some measure the failure to obtain satisfactory results from either medical or surgical treatment.

Moynihan, Hurst, and others believe that the tobacco habit is an important etiological factor in peptic ulcer. In a reported series of cases presenting a typical history of duodenal ulcer, but in whom ulcer could not be demonstrated, a large number were users of tobacco and in 90 per cent of the latter the X-ray showed pylorospasm. Nicotine may cause pyloric achalasia by its paralytic action on the sensitive vagal ganglia of the pylorus.

Infantile pyloric hypertrophy may be the result of intermittent clonic spasm of the sphincter beginning in intrauterine life and caused by preponderance of sympathetic influence or by impaired or tardy development

of vagal inhibition. An excess of adrenal secretion which is a powerful stimulant to the sphincter may be a factor. From the standpoint of the relationship between dysfunction of the pyloric sphincter and peptic ulcer it is significant that infantile pyloric disease and peptic ulcer occur with much greater frequency in males than in females.

The symptoms of duodenal ulcer are well defined and when faithfully elicited afford a diagnosis with only a small percentage of error. The early symptomatology while characteristic leads with disturbing frequency to operations at which no ulcer can be demonstrated. In other words, the symptoms of duodenal ulcer are sometimes present in the absence of ulcer. In these cases, gastro-enterostomy fails, but Bastianelli and Shoemaker, the former by



FIG. 4.—A, anterior half of sphincter removed. Closure of defect by suture which approximates outer coats of stomach and duodenum. B, diagrammatic view of completed operation.

the Rammstedt operation and the latter by partial excision of the pyloric sphincter have obtained satisfactory results. The existence of ulcer symptoms in the absence of a lesion probably indicates that ulcer is not necessarily the cause of the peptic ulcer syndrome, but that the latter is a manifestation of disturbed function of which ulcer may be a sequel. According to Hurst, peptic ulcer is insensitive to even a high concentration of hydrochloric acid. In absence of peritoneal irritation, pain from the gastro-intestinal tract is usually indicative of obstruction. Spasm of pylorus which may be painful in itself offers an obstruction to propulsive efforts of the stomach with resulting distention of antrum proximal to the sphincter—an adequate explanation of pain.

The symptoms in uncomplicated duodenal ulcer are often absent for periods of weeks or months although an ulcer undergoing repair has often been demonstrated in this interval. Symptoms are likely to be precipitated by nervous strain or by an indiscretion in diet. Such phenomena support the opinion that the symptoms attributed to ulcer do not depend upon the presence of an ulcer and can be explained by quiescence or abnormal activity of the pyloric sphincter. The fact that ulcer is present in the majority of patients who have the characteristic symptoms means that pyloric dysfunction, *i.e.* achalasia or spasm, which is the cause of symptoms, if long continued, favors the development of ulcer.

Experimental peptic ulcer has been produced by a variety of methods, and it is characteristic for most of these ulcers to heal promptly. According to Aschoff, acute ulcers occur in the stomach and duodenum with surprising frequency. In about 10 per cent of necropsies on adults, there are scars of healed peptic ulcers and in most of these cases there has been no history of ulcer. Chronic peptic ulcer is a lesion different from any of the above and is dependent for its maintenance on some change in gastro-duodenal physiology which for reasons previously cited is induced by pyloric dysfunction. By his method of surgical duodenal drainage Mann has produced with regularity an ulcer in the transplanted jejunum which in most respects resembles clinical duodenal ulcer. In these experiments, McCann found a normal gastric chemism. Such results seem to show that the jejunum cannot withstand the action of normal gastric juice and serve to emphasize the importance of the chemical factor in the causation of ulcer. Boldyreff noted that a duodenal ulcer sometimes occurred after ligature of the pancreatic ducts. It seems to be generally agreed upon that experimental gastric ulcers are slower in healing when emptying of the stomach is delayed. Bolton has shown that exposure of the gastric mucous membrane to an excess of free hydrochloric acid or to the prolonged action of normal gastric juice causes gastritis and the formation of multiple small ulcers. By appropriate tests Bolton, Elman, and Ochs have found that in clinical peptic ulcer there is delay, inefficiency, or failure of duodenal regurgitation to neutralize free hydrochloric acid in the stomach, the result of spasm or achalasia of the pyloric sphincter. It is not uncommon for the observant surgeon to find hypertrophy of the pyloric sphincter in cases of duodenal ulcer.

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The surgical procedures practiced in the treatment of peptic ulcer endeavor by chance or design to reduce acidity in the stomach and their efficiency has now come to be measured by the success or failure of this result. The degree of neutralization of acidity during the digestive and inter-digestive phases of the gastric cycle is not reflected in the analysis of the usual test-meal. The truth of this statement is attested by the fact that gastro-enterostomy cures many cases of peptic ulcer without appearing to change gastric acidity. In a reported series of sixty-nine cases of gastro-enterostomy complete anacidity was obtained in less than 3 per cent, yet the larger clinics report 85 to 90 per cent cures of duodenal ulcer by this procedure. Elman's studies have shown that in successful cases of gastro-enterostomy duodenal regurgitation and neutralization which were previously deficient due to interference by the pyloric sphincter have been increased by the operation. Other effects of gastro-enterostomy as shortened emptying time and relief of gastric tension are of secondary importance since excess acid or prolonged action of normal acid strength is the harmful factor. When a properly indicated and performed gastro-enterostomy fails, it does so by insufficient regurgitation through the pylorus or through the new stoma. The result is reactivation of the old ulcer or the formation of a new one near the anastomotic line. Gastro-enterostomy must accomplish more than normal reduction of acidity since the jejunum in some cases is probably vulnerable to normal gastric juice.

Partial resection of the stomach accomplishes the most decided reduction in gastric acidity because in the area removed are located the cells which stimulate acid secretion and cells directly responsible for acid, but the principal reason for low acid values is the very free regurgitation of duodenal contents provided for by the large anastomotic stoma. Acid cells are not entirely confined to a limited area of the stomach, so that the part remaining after resection secretes acid of the same strength but in less quantity, as formerly produced by the resected portion. The result of the operation is simply that neutralization is more than normally efficient. If for any reason it is not so, and such cases are being reported, jejunal ulcers form as they sometimes do after gastro-enterostomy. Success of operation will depend upon completeness of removal of acid cells and the efficiency of regurgitation to neutralize any acid that may be formed. The former is highly problematical and when it fails the only recourse is removal of more stomach.

Various methods of pyloroplasty have been practised with some success but not enough to justify general adoption. The reasons for failure as shown by X-ray studies and re-operations are that the activity of the sphincter was not completely abolished or that scar tissue and contracture produced obstruction at the outlet of the stomach.

There can be no doubt that some cases of verified peptic ulcer heal under medical management and in many of these symptoms recur when treatment is interrupted. Alkalies by mouth supply the deficiency of duodenal regurgitation and atropine in sufficient doses inhibits acid secretion, but such effects

cannot be conveniently maintained. The basic disturbance, pyloric achalasia, remains unaffected or readily recurs. Regarding the medical treatment of peptic ulcer Crohn and Reiss say, "Unless relief is had from the pylorospasm, we fail to note the disappearance of subjective symptoms." Gastric ulcer may heal in the absence of any form of treatment. Both Lewisohn and Whipple cite cases in which gastric ulcers verified by operation were shown at autopsy to have completely healed although no form of treatment had been carried out.

In the treatment of duodenal ulcer, Judd prefers excision of the ulcer combined with removal of the anterior half of the pyloric sphincter, completing the operation as a gastro-duodenostomy. Of his cases 60 per cent were cured and 92 per cent benefited. Gastric analysis showed little change from the condition prior to operation and the emptying time of the stomach was normal. In patients presenting a history of duodenal ulcer and in whom no ulcer was found nor any lesion to account for the condition, in such cases both Payr and Shoemaker have excised the anterior half of the sphincter without opening the submucosa. They report favorable results.

It is our opinion based on reasons previously given that peptic ulcer whether in the stomach or duodenum owes its existence to spasm or achalasia of the pyloric sphincter. It is possible that this condition could be corrected by appropriate drug therapy if such were known, or by division of the nerves to the part, as advocated by Schiassi, if they could with certainty be identified. A sure method for abolishing the activity of the sphincter is removal of its anterior half.

The procedure for the submucous removal of the anterior half of the pyloric sphincter is as follows:

With the stomach exposed the location of the pyloric sphincter at its distal end is readily identified by the short transverse veins. If there is any doubt as to the exact site of the sphincter mechanical stimulation of the pylorus by tapping with an instrument will cause it to contract when it can be seen and felt.

By drawing the stomach out and to the left the assistant exposes the gastro-duodenal area under tension. The veins above and below the sphincter are ligated by catgut on a curved needle, the ends being left long to act as traction sutures. A transverse curved incision is made on the duodenal side and another on the gastric side of the sphincter. These incisions should be made with a sharp scalpel and carried down to the submucous layer which is recognized by its small blood-vessels. In order to facilitate its removal the sphincter should be thoroughly freed by sharp dissection from the underlying submucosa. The sphincter is now cut across at its lower border. At this point care is necessary to avoid opening into the bowel. Should this occur the opening can readily be closed by suture without interfering with the operation. The strip of tissue containing the sphincter is now peeled from the underlying submucosa with the aid of a scalpel and cut across at its upper border. The only bleeding occurs as a free ooze from

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the incised edges of the wound and frequent sponging is necessary to keep the area dry. In order to control bleeding, the defect on the face of the bowel is closed by a continuous suture of fine chromic gut which unites the incised outer coats of the stomach to those of the duodenum over the submucosa.

By experiments on the cadaver and on the dog it has been shown that this operation does not produce narrowing of the bowel nor any appreciable infolding of tissue into its lumen. Scar tissue is reduced to a minimum and leakage prevented by avoiding injury to the submucosa.

For the purpose of mastering the details of the operation it is advisable to carry out the procedure several times on the cadaver when it will be found that it can be done safely and in a brief time.

SUMMARY

Pyloric achalasia is defined by Hurst as failure of a sphincter to relax. This failure, in the case of the pyloric sphincter, is chiefly operative against duodenal regurgitation, the major factor in the reduction of gastric acidity. Thus, incident to retention, there is prolonged exposure of the stomach mucosa to a highly acid content, which in turn is forcefully squirted into the duodenum causing both chemical and mechanical trauma, predisposing factors in the development of ulcer and active factors in its persistence.

The permanent success of gastro-duodenal surgery, exclusive of that applied to malignancy and obstructing deformities, is dependent on ready passage of gastric content and free regurgitation into the stomach of pancreatic and biliary secretion.

Of the methods of insuring these results, Judd's ulcer resection combined with partial pyloromyotomy, the Finney-Haberer operation and Billioth No. 1 are least disturbing to normal function.

With a reasonably assured diagnosis of pyloric achalasia, in the absence of demonstrable ulcer at operation, or even if a non-deforming, non-obstructing one be present, resection of the accessible portion of the pyloric sphincter without opening the mucosa, offers the least traumatizing method of accomplishing the desired results.

Neither this nor any other operation gives promise of more than transient betterment in the neurotic type of patient characterized by multiple manifestations of autonomic imbalance.

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DISCUSSION DR J SHULTON HORSLEY, of Richmond, Va, said that the operation for partial excision of the pyloric sphincter to relieve pylorospasm seems to have no advantage over pyloroplasty, in which not only the sphincter but the muscles of the pyloric canal, which is about one and one-fourth inches in length, are divided and sutured transversely, thus interposing tissue from the stomach around the gastric end of the incision between the divided ends of the pyloric sphincter. A chain mechanically is just as effectively broken by removing one link as by removing a half-dozen links, but when only a part of the pyloric sphincter is excised as described, the calibre of the pylorus is not increased and the fibrous tissue that takes the place of the excised portion of the pyloric sphincter is a direct connection between the two ends of the pyloric sphincter, and if this fibrous tissue tends to contract it may even decrease the calibre of the pylorus. In the pyloroplasty mentioned, however, additional tissue is interposed between the divided ends of the incised sphincter which should permanently increase the calibre as well as relieve the spasm from the sphincter and the muscles of the pyloric canal.

It must be recalled that the innervation of the pyloric sphincter is different from that of the external sphincter ani, which consists of striped muscle and is innervated as striped muscle usually is, whereas the pyloric sphincter has smooth muscle and contracts partly from the extrinsic innervation of the vagus, but largely through the myogenic influence itself, as Alvarez has shown. It seems probable that even the extrinsic nerve supply of the remaining portion of the pyloric sphincter is not affected by excising an anterior segment of it.

THE DILATED DUODENUM

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ALTHOUGH the literature of surgery contains a considerable number of illuminating articles written by surgeons upon the chronically dilated duodenum, it is only lately that internists have begun to pay any attention to the subject. Books upon internal medicine hardly mention this pathology as differentiated from that of gastric, gall-bladder, or even duodenal ulcer pathology, which it so often imitates. Only one book—that of Duval and his collaborators¹—has discussed the dilated duodenum in a worthwhile fashion, and only two works on surgery in English, mention anything helpful.

The title of this communication refers to the chronically dilated duodenum. The acute dilatation of the stomach is, I believe, the after-clap of a chronically dilated duodenum developed by some obscure irritation within the duodenum, or mechanical pressure from without at the area of the cause of the chronic dilatation. Rokitsanski² suggested this in 1849.

In practice, the pathology of the symptomatology of the upper quadrant of the abdomen, particularly on the right side, is daily a question as to the identity of its specific location, and we must acknowledge that it is sometimes difficult to differentiate with accuracy the primary location involved. Something has been done to clear up the maze with which the dilated duodenum has surrounded the symptomatology, not infrequently attributed to ulcer of the stomach or duodenum, cholecystitis, and chronic pancreatitis, but in the absence of positive X-ray corroborative findings, nothing conclusive has been worked out. There are, however, rather suspicious symptoms which may make one think of a dilated duodenum. The Cleveland Clinic³ has recently published the expression of Doctor Crile and his collaborators in this respect. They think that they have arrived at a position where they may conclude "that chronic dilatation of the duodenum is a clinical entity." As Adams says,⁴ discussing the question of diagnosis, "It would seem more reasonable to state as Moynihan has with regard to gastric ulcer, that the only two persons who can make the diagnosis with certainty are the radiologist and the surgeon, and the latter can only do so after the abdomen is opened."

Inflammatory adhesions resulting from gall-bladder infection or duodenal ulcer, not infrequently deform the first or second portions of the duodenum, likewise there may be some angulations resultant from congenital bands, but none of these is apt to produce interference with duodenal function except occasionally, when temporarily so much angulation is produced as to cause more or less obstruction which is reflected in stomach retention. These attachments are supramesocolic and are in evidence symptomatically, causing

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discomfort or pain while the stomach is emptying itself after a meal. Most of the dilatations of the duodenum, however, have their origin from sub-mesocolic obstructions. Aside from the occasional congenital bands which may compress the duodenum at its third portion causing more or less dilatation above, practically all third-portion dilatations are caused by the third portion being pressed against the third lumbar vertebra, where it is crossed by the mesentery and its contained blood-vessels. Seymour Bailing⁵ emphasizes this and says in explanation, "The fixation of the duodenum occurs primarily by fusion of the mesoduodenum with the mesocolon and the structures lying in the neighborhood of the right kidney. The neighborhood of the third part of the duodenum is the pivot around which intestinal rotation occurs, rotation which brings the cæcum across from the left side of the body to the right side of the body, and carries the root of the mesentery of the jejunum and its contained superior mesenteric artery and vein across the duodenum near its junction with the jejunum."

An ascending colon which after rotation descends well down and is loosely fixed to the parietal peritoneum—even having a mesocolon—does, with the lower ileum, cause traction upon the mesentery. This traction results in pressure upon the third portion of the duodenum. It is exaggerated when the cæcum is mobile and it with the lower ascending colon is filled with intestinal contents. Sometimes the accumulating effects of a general visceroptosis may be the determining cause of the production of damming-back symptoms referable to the duodenum.

Personally, I believe with Duval that a series of X-ray studies is the only reliable means of making a diagnosis of a dilated duodenum.

The outstanding symptoms in subjects who harbor a chronically dilated duodenum, as I analyze them, are discomfort or pain in the right upper abdominal quadrant, less often in the epigastrium, pain in the back, usually radiating from the frontal locality, headache, nausea, and often vomiting. There is invariably constipation. There may be occasional attacks of diarrhoea. When the symptoms complained of are mostly constant there is positive loss of weight, sometimes extreme. Those who lose weight are always nervous and generally hyperæsthetic.

Let me describe, as I did on another occasion,¹ one case rather fully, and then bring out briefly corroborating points in several other cases which to my mind may be helpful in differentiating the symptomatology of the chronically dilated duodenum from that of the very common pathology so frequently met with in the right upper quadrant of the abdomen.

CASE I—A young lady, twenty-two years old, had been seen by me off and on, with her physicians, for an indefinite pain somewhere over the gall-bladder region. This pain sometimes radiated toward her back. Her appendix had been removed. Her chief complaint was migraine, and when she vomited it was always bile—not undigested food. Her appetite was capricious. She was much below weight. She was nervous, *i.e.*, tempera-

* Sectional Meeting, American College of Surgeons, Sioux City, Iowa, November 15, 1927.

mentally so. All resources for a positive diagnosis were again and again exhausted. It was decided that the young woman was probably suffering from a low grade infection of her gall-bladder. She was operated upon by me January 17, 1927, in the Clarkson Hospital. On exposure the stomach and gall-bladder, to my eye and touch, were normal, but the duodenum was markedly dilated by the pressure of a band in the mesocolon which I could not divide. A duodeno-jejunostomy was done. The patient made a fine recovery, her nausea disappeared, appetite returned, and she was a new young woman. Unfortunately a mishap occurred. Six months later she developed progressive symptoms of an intestinal obstruction. This was taken care of by dividing a band partially encircling the upper ileum. The gall-bladder was removed at the same operation, as her physicians were confident it harbored trouble. My opinion is that this gall-bladder was normal, although the pathologist reported it as a chronic cholecystitis, Grade B. The young woman is to-day in fine health, having gained thirty-five pounds in weight. Her nausea, headache, and nervousness are gone.

CASE II—A woman, age thirty, a nurse, entered the University Hospital and was assigned to the neurological department, May 7, 1927. Her history showed that in 1900 she had been diagnosed as having a gastric ulcer and had been on diet treatment for one year. Since August, 1922, she had constantly complained of anorexia, nervousness, frontal headache, nausea, and vomiting (bilious). Her appendix had been removed and this operation was followed by another for adhesions. She had had a femoral phlebitis as a complication. Present symptoms. Weight about eighty-five pounds, pain in upper abdomen and back, the whole abdomen hyperæsthetic. At this time I suspected her as suffering from a chronically dilated duodenum and said so. The X-ray report was confirmatory. It said in brief, "Good duodenal cap, second part seems spastic, third part dilated and filled with barium." I did a duodeno-jejunostomy. The gall-bladder was normal. She was in my office recently, has gained twenty-five pounds and is in excellent health. All of her symptoms have disappeared although she says her stomach disturbs her at times.

CASE III—A man, thirty years of age, a rancher, entered the University Hospital, April 30, 1927. He was thin but rugged. His history dating back, suggested a duodenal ulcer or a mild gall-bladder infection. He had frequent attacks of pain in the upper abdomen and had acquired a mild but positive morphinism which was obscuring. He had headache and vomiting. Careful laboratory tests as to gastric or duodenal ulcer or gall-bladder infection were negative, yet we believed that he had pathology in the right upper quadrant justifying exploration. All that I found was a markedly dilated third portion of the man's duodenum, caused by a compressing mesenteric pedicle. A duodeno-jejunostomy was done. The result was extremely satisfactory. Unfortunately he has drifted and we have lost touch with him.

CASE IV—A young woman, a nurse, was a headache sufferer and had had several attacks of cholecystitis which interfered with her duties. I operated upon her August 9, 1927. Her gall-bladder looked quite normal but I removed it. It turned out to be a "strawberry" gall-bladder. The third portion of her duodenum was markedly dilated by a peritoneo-mesocolic band which I divided. It was interesting to see the dilated duodenum collapse as the band was divided. The recovery of this young woman has been most satisfactory.

CASE V—A rather spare woman, age forty-nine, married, no children, entered the Clarkson Hospital, February 1, 1928. For more than a year she had been complaining of headache, nausea, belching, and bilious vomiting. She had complained of pain in the upper abdomen for several years. This pain radiated toward the back. She had lost considerable weight. An X-ray disclosed a very much dilated duodenum. Peristalsis was plainly seen traversing the duodenum and then changing to reverse peristalsis. The entire duodenum hung as a loop—its bottom coming below the crest of the ilium. There was apparently some undetermined interference at the duodeno-jejunal junction. She was operated upon by me February 10, 1928, and a duodeno-jejunostomy done. There

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has since been marked improvement in all of her symptoms. The reverse peristalsis is gone and her neurotic condition has changed for the better.

The duodenum in the transverse mesocolon is below the lesser cavity of the peritoneum, lies in a bed of connective tissue and is covered by a single layer of peritoneum. If a hanging, angulated right colon is the offending agent this should be tacked up by some sufficing method. McConnell and Hardman⁵ report a large series of such cases successfully treated by this technic. I do not agree with Bloodgood, who advises and has on several occasions resected the cæcum and ascending colon as the proper method of overcoming the difficulty. Good results are obtained by doing a simple, safe colopexy. A duodeno-jejunostomy is the operation of choice when not contraindicated by a simpler method as a colopexy. The resection of the lower ileum and the ascending colon should be reserved for cases otherwise not promising.

I would like to suggest a warning in regard to the doing of a duodeno-jejunostomy. When the transverse mesocolon is loaded with fat and the subject happens to have a heavy abdominal wall, it may be difficult to expose the duodenum and release it sufficiently to bring it into a position in which a safe technic of a duodeno-jejunostomy is practicable. In such an instance it may be wise to resort to the next best procedure, a gastro-jejunostomy. In a recent instance of this kind my patient died several days after being operated upon, and the autopsy disclosed an acute pancreatitis. There was fat necrosis in the omentum and the head of the pancreas was commencing to break down. Although the pancreas was exposed when freeing the duodenum I was not aware of any traumatism to it.

Again it must be remembered that the duodenum is not always situated as described in our anatomies. The loop may be found at the second lumbar vertebra, sometimes at the fifth, and its position will influence its motility and the ease with which it can be manipulated. Medical treatment of the dilated duodenum is, of course, of value. Diet, the duodenal tube, calomel and saline laxatives, the abdominal belt, posture, knee chest, (the foot of the bed raised) when the colon is at fault, all may be helpful.

Let me make another suggestion. When operating for supposed or known pathology in the right upper quadrant of the abdomen, on exposure of the duodenum, should it seem abnormally dilated, lift up the colon with its attached omentum, and inspect the mesocolon to the right of the mesentery where it naturally crosses the duodenum. You may find more or less dilatation of the third portion of the duodenum requiring surgical procedure.

Physicians should give this subject more attention. The pathology is not very uncommon, a reasonably safe symptomatology may be worked out and its relief by surgery is satisfying when other means have failed.

Byron Robinson⁶ in America and Petit⁶ of Paris, a pupil of Campenon, described cases of chronic duodenal obstruction. The former intervened surgically in two patients suffering from various symptoms of indigestion.

operated in 1900, and found no other lesion than a premesenteric dilatation of the third portion of the duodenum. Petit described and executed a duodeno-jejunostomy on the cadaver in 1900. Finney, in 1906,⁶ described incomplete stenosis of the duodenum from mesenteric origin, as a cause of indigestion. Important articles by Bloodgood⁷ and Kellogg⁸ have done perhaps most to direct attention to the dilated duodenum. The personal work of E. P. Quain of Bismarck, N. D., and his very recent translation of Duval's book will do much in the future to interest the profession in this neglected field.

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DISCUSSION DR. LEONARD FREEMAN, of Denver, Col., called attention to a form of obstruction of the duodenum that is a persistence from fetal life. He had seen quite a number of these cases, perhaps because he had been looking for them, because what one does not think of and does not look for one is not apt to see.

The duodenum goes downward a short distance and then across the spine, and then is attached higher up at the duodeno-jejunal angle, the first one-fourth being free, but not the remainder, which is imbedded in connective tissue. In fetal life the whole of the duodenum is free, is much longer, and has a mesentery of its own. This sometimes persists into later life, so that the duodenum instead of passing across the spine rather high up, sinks low, in a long loop, down toward the pelvis. Doctor Summers mentioned such a case in his paper. But when it sinks low down in this way it nevertheless is always attached high up by the ligament of Treitz. That is always a constant point of attachment. Like hanging a rubber tube over a nail, it becomes kinked off at the point of attachment. Not only that, but there is also a twist at this point. This loop of duodenum being free and filled more or less with intestinal contents, sinks toward the pelvis and makes the kink greater. The difficulty being increased, as time goes on, by thickening and contraction of the supporting ligaments.

If those who are operating for dilatation of the duodenum will look carefully, they will find that such a condition as this is responsible much more often than has been generally recognized. It may be corrected sometimes by freeing the point of attachment and sometimes by a duodeno-jejunostomy, according to circumstances.

THE DILATED DUODENUM

DR EMMET RIXFORD, of San Francisco, Calif., said that, in connection with Doctor Summers' paper, he was reminded of a demonstration that was made in the Museum at Harvard Medical School some years ago in which a number of wax casts of the duodenum made by the late Professor Dwight, professor of anatomy, were shown. He had injected the duodenum with melted wax. The casts showed very wonderfully many of these variations and particularly the crease on the anterior surface of the transverse portion of the duodenum which is made by the superior mesenteric artery.

DOCTOR BALFOUR (in closing) said that although he may have given the impression that partial gastrectomy is to be condemned, there is no operation which will give better results in selected cases. It does not necessarily protect the patient against subsequent ulceration, and when such ulceration does occur the problem of further surgical treatment is much more difficult to solve than when a similar type of operation has been the primary one.

Repeated resections do not appear difficult in a diagram, but it is hardly necessary to say that they may be extraordinarily difficult technically. Worse than this, even if a satisfactory operation has been done from a technical standpoint, one cannot be certain that the patient is going to be in good health afterward.

DOCTOR SUMMERS (in closing) Apropos of the motility of the duodenum, some ten years ago he was asked to remove a large open safety pin from the stomach of an eleven-months-old child. The X-ray showed the pin in the stomach. He opened the abdomen. The pin was not in the stomach but its point was fastened in the wall of a very mobile duodenum. He could handle the pin, so much so that he was able to manipulate it and close it, instead of opening the gut and taking it out. About a week or ten days later the child passed the pin naturally.

THE VALUE OF THE RECTAL TUBE IN OPERATIONS FOR ACUTE ABDOMINAL CONDITIONS

BY HERBERT A. BRUCE, M D F R C S , ENG
OF TORONTO, CANADA

FOR a number of years I have been in the habit of inserting a rectal, or more properly speaking, a colon tube, before closing the abdomen after operations for many acute abdominal conditions with such striking results that I thought it worthwhile to bring it before this association in the form of a special communication. I got the idea from seeing Sir Arbuthnot Lane use a long rectal tube in ileo-colostomy, and observing how free these patients were from distention and how easy it was to keep their bowels open.

A colon tube (32 inches long, with an eye at the side as well as the end) passed with a corkscrew motion by an assistant or nurse, can be guided up past the "tricky" rectum and through the sigmoid to the splenic flexure or higher, by the surgeon with his hand in the abdomen. It will then be seen how difficult or impossible it is without such help to pass a rectal tube up to or beyond the sigmoid, as it almost invariably becomes arrested at a point about four inches above the anus and then bends on itself and doubles up within the rectum. With the hand in the abdomen, it can be guided past this point and by alternately feeding the bowel over it and pulling on the tube, it can be made to pass to any distance. It should be passed well above the sigmoid as far as the splenic flexure, so as to ensure its remaining in position. It should then be secured by a stitch to the skin near the anus, and can be left for from four to six days as occasion may require.

The chief benefits to be derived from its use are

1 It permits of easy escape of gas and prevents distention of the large bowel

2 By holding the sigmoid flexure and the mesosigmoid across the brim of the pelvis it forms an effective shelf which prevents the small intestine getting into the pelvis

3 It enables one to give saline and glucose high up into the colon where it will have a better chance of being absorbed, and also to give enemata where they will be most effective

One of our greatest concerns after an operation for diffuse septic peritonitis, is to get an evacuation of the bowels the following day. This is greatly facilitated if the colon tube is beyond the sigmoid, thus enabling the enema to pass as high as the cæcum. In fact I feel confident that the overdistention of the intestines in paralytic ileus will be prevented in a considerable number of cases by the colon tube. It should be used in all cases of peritonitis from whatever cause in all cases of intestinal obstruction, whether mechanical or

THE RECTAL TUBE IN ABDOMINAL OPERATIONS

paralytic, and in many operations upon the female pelvic organs, to prevent adhesions to the small bowel or omentum

It was found most helpful in a recent case of volvulus of the sigmoid, in which a loop of this bowel was turned over and attached by a firm adhesion to the rectum low down. The sigmoid loop had evidently been in this position for a considerable time, for when the adhesion was separated and the loop lifted out of the pelvis, it immediately fell back into its acquired position. The rectal tube restored it and held it in its normal position, and was left in for a week, at the end of which time it was hoped the tendency to recurrence had been overcome. The patient made a good recovery.

Another typical case was that of a man aged thirty-five, who had a ruptured appendix with diffuse septic peritonitis and paralytic ileus when first seen, four days after the beginning of his attack. The appendix, which was gangrenous and perforated, was removed, adhesions of the small and large intestine were separated and drainage provided, and then a colon tube was inserted up past the splenic flexure to about the middle of the transverse colon. The obstruction was relieved within thirty-six hours and he made a good recovery, which we believed due to a very large extent, to the use of the colon tube.

In many cases the pelvic operations in which, after the removal of diseased organs, raw surfaces were left which could not be peritonized, the expedient of using the sigmoid held in position by a rectal tube has effectually kept the small intestines out of the pelvis and prevented adhesions.

It would seem unnecessary for me to recite further the variety of cases in which a colon tube has been used with great advantage, in fact in which it was believed to have turned the scale in favor of recovery. Any desired medication can be given through the tube in addition to saline or glucose without fear of the rectum becoming intolerant. In the intervals of treatment the tube should be left open, when gas and fecal matter will be found to escape.

Should the bowel become irritated by the tube, which it occasionally does, a warm oil enema will relieve it. If the tube should get plugged, it can be readily cleared by running some warm saline through it.

After an experience extending over many years, I feel confident in advising the use of the colon tube, put in place during an abdominal operation, as a life-saving device. I believe that it is just as valuable and important as the stomach tube has proven to be in preventing death from acute gastric dilatation.

RESECTION OF THE PANCREAS

BY JOHN M T FINNEY, M D

AND

JOHN M T FINNEY, JR, M D (BY INVITATION)

OF BALTIMORE, MD

IN PRESENTING this report of a single case of successful resection of a large portion of the pancreas, it is our purpose to draw attention to a condition possibly enlarging the field for the employment of surgery. Recent additions to our knowledge of the function and diseases of the pancreas, as revealed through clinical and laboratory research, have called attention to the condition reported as one potentially surgical in character. Owing largely, no doubt, to the influence of Mikulicz's well-known opposition, operative procedures of any sort upon the pancreas are comparatively rare—particularly those for primary disease of the gland, involving resection of a portion of its substance. Nevertheless, the literature on the subject of pancreatic surgery, both experimental and clinical, is fairly voluminous. But in a rather careful and exhaustive review, we are unable to discover the report of another case similar to the one we are presenting.

CASE REPORT—Mrs C W J, age fifty-three years, white, widow, was admitted to the Union Memorial Hospital, Baltimore, December 2, 1927. She had previously been carefully studied by physicians, both in this country and abroad. She was referred to us by Dr T P Sprunt of Dr L F Barker's group, to whom we are indebted for most of the laboratory reports.

Complaint—Spells of confusion, with mental lapses and strange behavior, during the past four years. Low blood sugar.

Family History—Father and mother living and well at eighty-nine and eighty-three years respectively. Four sisters and brothers alive and well. One brother died of tuberculosis. Husband died five years ago, at the age of forty-nine, of cancer of the pancreas. Never pregnant.

Past History—General health fair. Has been nervous and troubled with indigestion and constipation all her life. No serious illnesses. At the age of twenty-seven she had a severe nervous breakdown, characterized by marked depression. From this attack, recovery was slow. For about a year following her husband's death, there was again a period of rather marked mental depression, largely influenced, in all probability, by unfavorable environment. She lived in the same house as her husband's brother, who had an old infantile paralysis, associated with convulsive seizures and mental deterioration. This worried her greatly. She then moved to the home of her father, who was a pronounced religious fanatic. Later, she took up teaching, to occupy her time. She found herself much older than the other teachers with whom she was associated, and had great difficulty in making the new adaptations necessary. It was at about this time, four years ago, and coincident with the menopause, that the first attack occurred.

Physical Examination—Head. Occasional headache. Has worn glasses for many years. Much trouble with teeth, infrequent tonsillitis. Prominence of the thyroid for several years.

Cardio-respiratory—Essentially negative.

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Gastro-intestinal—Chronic indigestion and constipation, appetite fair Hæmorrhoidectomy, 1923

Gentle-miscary—Menses, onset at fifteen years, slight dysmenorrhœa D and C in 1902 Menopause at age of forty-nine

Skin—Eczema of hips and perineum twice—in 1921 and 1924 Treated with X-ray each time

Skeletal—Negative

Nervous—Marked instability, always irritable, easily depressed

Present Illness—Began four years ago, coincident with her menopause At first the attacks were slight and infrequent The only thing noticed was that she would seem dazed, could not concentrate or think clearly, and sometimes would "see double" The attacks at that time would be of but a few minutes' duration, with no after effects Since first noticed, they have become steadily worse, more frequent and more prolonged After a year and a half, she became alarmed about her health, and went to Europe for a rest During the year spent there, she thinks she had possibly six or eight attacks They usually occurred before breakfast, but had not as yet come to be definitely associated with the taking of food Any alarm or trouble might precipitate an attack Once or twice she fell while walking, but was conscious of no dizziness, and was able to arise immediately and continue During the past eighteen months, the attacks have increased rapidly both in number and severity, until now they have become of almost daily occurrence,—usually in the morning, before breakfast

A typical attack is described as follows—she can generally tell when one is imminent by her eyes If reading, they become crossed and she has great difficulty in properly focusing them Or, they may become fixed in a stare, with dilated pupils Then the head begins to jerk unsteadily and roll from side to side Then she cries out At the height of the attack, she screams and throws herself violently about—almost like a convulsion There is at times some frothing at the mouth There has never been any biting of the tongue, or other physical injury during an attack, nor any loss of sphincteric control Everything that occurs during the attack is hazily remembered by the patient afterward She feels exhausted, both mentally and physically The attacks last from fifteen minutes to several hours Upon one occasion she says she was semi-conscious for a whole day The most interesting feature about these attacks is that they may be aborted in a few minutes if, at the first warning of their approach, the patient takes a few mouthfuls of shredded wheat biscuit and cream If the attack is allowed to progress further, the time of recovery after taking food varies, but the patient says it is not as prompt now as a couple of years ago From September to December, 1926, while under treatment at a sanatorium, on forced feedings and bromides, she had no seizures at all

Physical Examination—Height 5 feet $2\frac{3}{4}$ inches, weight 140 pounds—about fifteen pounds over average Temperature, pulse and respirations normal, blood pressure 116/80

The examination was essentially negative, except as follows—mild gingivitis, with several questionable teeth There is moderate diffuse enlargement of the thyroid, with one definite nodule about 1.5 cm. in diameter situated in the isthmus, just to the right of the midline Several spots of eczematous looking eruption on the hips, and inner-surfaces of the thighs Examination of the nose throat heart lungs abdomen pelvis and neurological system all negative X-ray examination of the chest, gastro-intestinal tract, skull sinuses and teeth were also negative The eye examination showed slight compound hyperopic astigmatism, with slight exophoria and hypophoria—corrected by lenses

The reports of the various laboratory and chemical analyses are the most interesting data in this case and on them was based the tentative diagnosis of hypoglycæmia or hyperinsulism which determined the subsequent course of action We have reports on analyses made elsewhere during the past two years These are incorporated with our own

Urine Examination, September 11 1925—Negative except a little albumin

Blood Chemistry, September 17, 1925—Uric acid 58 mg per 100 cc, NPN 420 mg per 100 cc, Sugar 2285 mg per 100 cc

One week later, September 25, 1925—Sugar 1340 mg per 100 cc, hæmoglobin 94 per cent Red blood cells 4,864,000 White blood cells 8,500

Kidney function (phthalein output) 42 per cent in two hours Exactly one year later, September 25, 1926, the blood sugar had dropped to 41 mg per 100 cc One month later, October 26, 1926, the fasting sugar at 8 A M was 79 mg, which following a glucose tolerance test rose rapidly to 232 mg at 8 30 A M, then dropped slowly to 196 mg at 9 A M and to 192 at 10 A M During this time, the specific gravity of the urine varied from 1 010 to 1 020, but at no time was there any sugar in the urine

During May, 1927, a blood sugar report was 30 mg, fasting, and only 70 following glucose The laboratory observations made just prior to her admission to the hospital for operation show essentially the same findings

Gastric analysis was normal, with free HCl content of 26 per cent, total acidity of 50 per cent Stool examination negative Urine negative, except for faint trace of albumin A wide series of protein sensitization tests were all negative Blood Examination October 3, 1927 Hæmoglobin 80 per cent Red blood cells 4,506,000 White blood cells 6,200, with a normal differential and platelet count and no abnormal cells Blood Wassermann was negative Uric acid 34 mg per 100 cc NPN 345 mg per 100 cc Blood sugar (fasting) 52 mg per 100 cc Blood sugar the following day (done after basal metabolic test) was 40 mg per 100 cc

Glucose tolerance test showed blood sugar content of 52 mg before administration, 192 at $\frac{1}{2}$ hour, 135 at $1\frac{1}{2}$ hours, 111 at $2\frac{1}{2}$ hours This gives a normal reading except for the abnormally low fasting blood sugar to begin with No sugar appeared in the urine at any time Two basal metabolic readings, at different times, gave minus 9 and minus 6 respectively The spinal fluid showed a negative cell count and globulin reaction, negative Wassermann and sugar content of 34 mg per 100 cc

Many subsequent blood sugar estimates were essentially the same as those given above

There were certain other experiments of considerable interest and importance, which were tried At one time, ten units of insulin were given hypodermically, with the immediate production of an attack From this attack she recovered with equal rapidity, following the intravenous injection of a glucose solution On another occasion, ten units of insulin were given intravenously, together with twenty grams of glucose, without the production of an attack At the time of these experiments, the blood sugar was at a normal level before the insulin was given During the attack, it was very low—from 20 to 30 mg per 100 cc Immediately after recovery, following the injection of the glucose, it had again become normal On the other hand, at another time, while in the fasting state, with a very low blood sugar, near her danger level, a hypodermic injection of 10 minims of adrenalin prevented the occurrence of an attack, and an hour later, the blood sugar was found to be normal The same result was obtained by the injection of pituitrin, hypodermically and, also, though less promptly, by the use of pituitrin intranasally Ephedrin solution had no effect whatever in warding off an attack

Patient was examined by Doctor Hohman of the Department of Psychiatry, who reported as follows "If it were not for the fact that there is a very striking lowering of the blood sugar and that the taking of carbohydrates aborts the attacks, my feeling would be that these attacks were certainly hysterical"

From these various studies, we felt that it had been shown pretty conclusively (1) that the attacks were always associated with and, therefore, presumably due to, the hypoglycæmia, (2) that there was apparently a plentiful store of glycogen in the body, and that it could be readily mobilized by taking food, or by the exhibition of certain drugs, namely, the injection of adrenalin or pituitrin, or the use of pituitrin as a nasal spray, (3) that there was a marked sensitiveness to insulin, even in exceedingly small doses, as evidenced by the rapid onset of a typical attack immediately following its

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introduction This raised the question as to whether we were dealing with a case of over-production of insulin, or with one showing a marked hypersensitiveness to a normal amount, also as to whether we were dealing with a metabolic disturbance produced entirely by an organic disease, or by a functional disease or by a combination of the two

In view of the close similarity of the findings in this case to those in the case reported recently from the Mayo Clinic by Doctor Wilder and others, we felt that an exploratory operation was certainly warranted, to determine the condition of the pancreas, and that if then it appeared advisable, a partial resection of the pancreas would be undertaken in the endeavor to diminish the glandular substance concerned in the production of insulin, i.e., Islands of Langerhans This latter procedure seemed warranted, whether we were dealing with a case of true hyperinsulinism, or one of hypersensitiveness to a normal amount of insulin In either case, the reduction in the insulin output should, at least theoretically, materially benefit the individual

The patient was frankly told that such an operation would be in the nature of an experiment, but she was so incapacitated and depressed by the frequency and severity of her attacks, that she was not only willing, but anxious to take advantage of any chance that offered a prospect of relief Accordingly, she entered the Union Memorial Hospital on December 2, 1927, and the operation was performed the following morning

In preparation for the operation, the patient was given four drams of glucose every half hour for several doses Operation was done under ether anaesthesia An ample left rectus incision was made From the mid-portion of this incision, and extending laterally below the left costal margin, was a second incision, about five inches in length, the result being a T-shaped opening, giving excellent exposure of the whole upper portion of the abdomen The approach to the pancreas was through the gastro-colic omentum, the stomach being retracted upward and the transverse colon downward

On inspection and palpation, the pancreas seemed normal in size, shape and consistency The liver appeared to be perfectly normal, in fact, on general exploration of the whole abdominal cavity, nothing abnormal was made out Owing, however, to the persistent, unexplained hypoglycæmia, it was decided to resect a portion of the pancreas, for the reasons above mentioned Accordingly, beginning at the tail, the pancreas was carefully mobilized and dissected out of its bed until approximately two-thirds of it had been freed This was accomplished without great difficulty by careful dissection, without injury to surrounding structures and without hemorrhage of any note, except at one point, where it was momentarily feared that possibly the splenic vein had been injured It proved, however, to be only an aberrant branch, which was easily secured When as much of the pancreas had been mobilized as it seemed wise to remove—about two-thirds of it—the body of the gland was divided by a V-shaped incision, and the resulting flaps of pancreatic tissue were brought together and sutured with continuous plain catgut, which effectually covered in all the raw surfaces and controlled the oozing therefrom The line of suture of the pancreas was then turned under and covered with fat and retroperitoneal tissue, by interrupted sutures of plain catgut

A small wedge-shaped piece was removed for examination from the edge of the left lobe of the liver

The spleen showed no evidence of disturbance to its blood supply The toilet of the peritoneum had been so satisfactorily completed that we deliberated as to the advisability of drainage It was decided, however, in the affirmative, and a cigarette drain was placed in the vicinity of the stump of the pancreas, and another in the bed from which it had been removed The wound was closed in layers, in the usual manner, with catgut and silkworm gut

The patient stood the operation well The blood sugar, from a specimen taken immediately after operation, was 230 mg per 100 c.c. She returned to her room in good condition Shortly thereafter, there developed a period of apparent cardiac depression But, following vigorous stimulation and the administration of 500 c.c. of 10 per cent

glucose solution intravenously, the patient's condition rapidly improved. The evening following the operation, her condition was excellent—pulse around 90, temperature normal, blood sugar 247 mg.

For the first three or four days after operation, the patient was quite uncomfortable from rather persistent nausea and vomiting, necessitating gastric lavage.

December 4—the day after the operation—the blood sugar was 244 mg, with a two plus sugar reaction in the urine. This was the only time during her hospital course in which sugar was observed in the urine.

December 5, the pulse and temperature both rose rather markedly, the former to 120, the latter to 104. The wound was dressed and showed evidence of slight infection in the lateral incision, although this did not appear to be sufficient to account for the temperature. Blood sugar 140. Blood pressure 120/65. In view of the falling blood sugar, it was thought wise to begin giving glucose again, so this was done in three dram amounts, every two hours. December 6, blood sugar 61.5. December 7, 78 mg, shortly following a dose of glucose. December 8, 57.1. December 9, 57.1.

On the ninth day following operation, blood sugar was down to 44 mg. There was a slight reaction about 11 A.M., when the patient complained of feeling faint and chilly, fingers and toes tingled and the pulse became rather rapid—around 130. Six drams of glucose brought the patient out of the attack almost immediately. Wound in good condition, except for some slight evidence of infection along the drainage track. Last drain removed and Dakin tube inserted. Irrigations with Dakin's solution instituted. There was no evidence at any time of pancreatic fistula, thus confirming our impression at the time of operation that owing to the satisfactory closure of the pancreatic stump, drainage was unnecessary. The danger of the development of retrograde infection along the drainage track, such as occurred here, might thus have been avoided.

From December 12 to December 20, the patient had light attacks almost daily, usually the first thing in the morning, occasionally at other times during the day. None of these attacks were severe, nor did they progress beyond the point of the patient complaining of uncomfortable sensations with a peculiar staring expression of the eyes, facial grimacing and general restlessness. At all times, the administration of a few drams of glucose immediately aborted an attack. It seemed to everyone who saw her that these attacks were much more characteristically hysterical than they had been before operation. The blood sugar during this time ranged from 60 to 45, usually nearer the former figure. The wound was cleaning up nicely, the discharge rapidly diminishing after the institution of Dakin irrigations, sinus tract closing in nicely, pulse and temperature practically normal.

December 20—the eighteenth day after operation—there was quite a severe attack—patient grimacing violently, eye slits widely dilated, kicking her feet in the air and screaming. At all times she was perfectly conscious of what was going on. Within a few minutes of taking a few mouthfuls of shredded wheat, sugar and milk, the attack subsided. It was followed by a crying spell, and the patient was very much depressed for the rest of the day. Vena-puncture was done during the attack and the blood sugar was 50 mg. (A glucose tolerance test the following day showed 60.6 mg. in the fasting blood, 198 mg. after one-half hour, 312 mg. after one hour, 189 mg. at two hours.)

From this date until her discharge, January 20, she remained in a rather depressed frame of mind, sure operation was a failure, but having only occasional, quite mild attacks. Blood sugar continued to vary between 45 and 70. The wound healed rapidly and well, and at the time of her discharge, drainage sinus was reduced to a very small defect, barely admitting the end of probe.

Another psychiatric examination was made by Doctor Richards, with the following report: "I feel that the above-mentioned spells are wholly psychogenic in origin, which one sometimes finds in middle-aged, depressed women. I believe that the low blood sugar is a secondary feature of the picture of distress as a whole, and that it is a phenomenon which has to do with the influence of extreme emotional states upon sugar

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metabolism" This report confirms that of Doctor Hohman, made previous to the operation

Following her discharge from the hospital, the patient returned to one of the sanatoria where she had previously been, for a period of rest and recuperation

Pathological report on the specimen of pancreas removed*—a portion of grossly normal looking pancreatic gland, irregular in shape and outline, roughly 11.5 x 4.5 x 1.5 cm in greatest dimensions, weight approximately 22.5 grams. Small wedge-shaped piece of normal looking liver

Microscopic diagnosis—pancreatic structure apparently normal. There is no demonstrable change in the Islands of Langerhans. Liver normal

The question, of course, now arose as to whether or not the operation had been of any benefit, whether our diagnosis was correct in considering her a case of hyperinsulism, rather than hysteria, and whether the operation was a justifiable procedure, in the face of a questionable diagnosis. We were dealing with a patient who quite evidently had a very marked back-ground of psychogenic and neurogenic disturbances. She was the type of individual, and at the age, where one would expect such manifestations to play an important rôle, if at all. On the other hand, by repeated examinations, over a long period of time, it was very definitely proven that she constantly ran an abnormally low blood sugar and that, so far as we could determine, the occurrence of her attacks was markedly influenced and apparently dependent upon the periods during which the blood sugar was at its lowest. Moreover, it seemed difficult to believe that anyone could psychogenically influence their metabolic rate to such a marked degree. It is an all too common practice to blame many and varied complaints and phenomena which we cannot otherwise explain, on the hysterical or neurotic temperament of the patient. It seemed, therefore, the course of wisdom to attack the organic basis first, since it appeared that the danger of such an operative procedure as was proposed, although unusual, was not so great as to render such decision unwarranted, rather than arbitrarily to assume her trouble to be purely psychopathic.

The evidence now would seem to point toward a purely functional disorder, since we can discover no apparent disturbance of the pituitary gland, nor of the adrenals, and very little evidence of disturbed thyroid function. It may be that there is some difficulty in the usual mechanism of the mobilization of glycogen, although we know that glycogen can be readily mobilized by the taking of food or by the injection of pituitary and adrenal products.

In view of the apparent influence that the operation had upon the blood sugar level,—for although it did not return to normal, it was consistently higher post-operatively than pre-operatively—would it be unreasonable to suppose that we may have been dealing with a combined functional and organic disease? On such an assumption, we have certainly placed the patient in a better position to overcome the functional element than had we disregarded the organic aspect. Time alone, of course, can tell just how much good has been accomplished.

* (Dimensions of normal pancreas as given in Gray's Anatomy, 18.5 x 4.5 x 1.5 to 2.5 cm, weight 60 grams for women.)

At the meeting of the American Surgical Association in May, 1910, we reported a case of successful resection of a large portion of the pancreas, for a solid tumor which we thought at the time was malignant, but which proved to be a benign cyst-adenoma. The status of surgery of the pancreas has changed very little in the intervening eighteen years. There still exists the disposition to regard the pancreas as an organ which is to be surgically shunned, if possible.

Judging from the literature and from personal experience and observation, the commonest surgical condition met with in the pancreas, is the formation of cysts. Since they are essentially benign in character, all that is necessary in dealing with them is excision or enucleation of the smaller cysts, where possible, marsupialization and drainage of the larger ones, when necessity demands, (Santy, Dennis, Riese, etc.)

One branch, however, of the literature has been considerably enriched during the intervening period, by reason of the late World War—that is, the subject of traumatic injury to the pancreas, chiefly in the articles of Wallace, Makins, Maisonneuve, Korte, Haberer, Bardeleben, etc., and a number of scattered cases referred to by Riese in his excellent monograph on surgery of the pancreas. There are also occasional reports from civil practice of trauma to this organ. One very interesting article, that of Kubota, deals with the various aspects of experimentally produced trauma of the pancreas in animals.

Acute hemorrhagic pancreatitis continues to be somewhat of a “bugbear” to surgeons, although, fortunately, it is of comparatively rare occurrence, (Hoffmann, Riese, etc.)

Occasional reports are to be found of cases involving resection of tumors. Many of these are cases in which the pancreatic resection was merely incidental to, and necessitated by, a massive resection of stomach or bowel, for malignant growth, which had involved the gland secondarily. (Bier, Kausch, etc.) We have recently removed both the spleen and a portion of the tail of the pancreas, in the course of a sub-total gastrectomy for carcinoma involving all these organs. There are a few isolated reports of resection for primary growths, both benign and malignant. Of the benign tumors, there are on record adenoma, fibroma, endothelioma, angioma and lymphoma. In most instances, the tumors presented no particular difficulty in removal, as they usually enucleated rather easily, (Cohn, Korte, Tancre, Arnani, Sandler, quoted from Riese and Kleinschmidt). Of the malignant tumors, there are a few cases of sarcoma and lympho-sarcoma on record, (de Queirvan, Maitens, Malcolm, etc.) The commonest malignant tumor is carcinoma, usually situated in the head of the pancreas, and hence lending itself less freely to surgical treatment. In Bavaria, Kolb, among 8777 deaths from cancer in males, found 54 pancreatic cancers, in 11,266 deaths from cancer in females, 50 pancreatic cancers. In two-thirds of all these cases, the tumor was situated in the head of the gland.

In any attempt to eradicate a growth in the head of the pancreas, one is

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confronted by the necessity of reestablishing the drainage of the pancreatic secretions into the bowel. Of necessity, in such an operation, normal drainage through the ducts of Wirsung and Santorini is interrupted. To reestablish this drainage, various types of operation have been devised, usually involving the implantation of the stump of the remaining gland into the wall of the duodenum or jejunum, (Franke, Desjardins, Sauve, Kausch, etc.) Such a procedure, from a technical standpoint, is extremely difficult, and, from the patient's standpoint, extremely hazardous, and it is doubtful if the results justify it.

The most interesting case, from our point of view, which was found in the literature is that recently reported from the Mayo Clinic, by Wilder, Allan, Power and Robertson. In that case, presumably a primary carcinoma of the Islands of Langerhans, with metastases to the liver and regional lymph glands we have a condition of the blood sugar quite parallel to that which we have just reported. Influenced largely by that report we reached the conclusion upon which was based the decision to operate in our own case.

SUMMARY

(1) Report of case, perhaps unique, of persistent, marked hypoglycæmia associated with attacks suggestive of either insulin shock or hysteria.

(2) Massive resection of pancreas as means of reducing number and output of Islands of Langerhans.

(3) Feasibility of removal of large portions of pancreas as comparatively safe and simple surgical procedure.

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INTERPOSITION OF A LOOP OF ILEUM TO REPAIR DEFECTS IN THE COLON

By HARVEY B. STONE, M.D.
OF BALTIMORE, MD

IN A previous communication,¹ the writer has presented an experimental study on the use of loops of ileum as grafts between the divided ends of the colon, and has referred to the scanty literature on the subject (Vignolo,² Soresi,³) This work was done entirely upon dogs. It proved the possibility of segments of ileum being successfully interposed between the divided ends of the colon, with complete preservation of the functions of digestion and defecation in spite of the abnormal arrangement of the intestinal loops. Vignolo² has reported a case that was to all intents a success, although the patient's disease prevented the completion of the operation. It is the purpose of this paper to present a successful clinical case in which this principle has been employed. The report is considered worthwhile, not only because of the success of an extremely novel procedure, but also to call attention to an adaptation of the methods of grafting to a field in which it is believed it may be used more often, with benefit to the development of abdominal surgery.



FIG. 1.—X ray plate of abdomen before operation, showing tube entering colostomy at point A and barium in colon. Straight descending colon and complete absence of sigmoid.

The case report, reduced to its essential features, follows.

The patient, a young woman of twenty-seven years, was first seen on January 9, 1928, being referred to me by Dr. Stephen H. Watts, of the University of Virginia. She had undergone two previous operations, the most recent and most important so far as concerns her present condition, being on June 10, 1926. The essential features of this operation, as supplied through the courtesy of the surgeon who performed it, were as follows. Through a midline suprapubic incision, a large mass was found in the left lower abdomen. After much difficulty in exploring this mass, it was found to contain sigmoid, rectum, left ovary and tube. An abscess in the cul-de-sac was opened containing two hundred or three hundred cubic centimetres of thick yellow pus. There was almost complete obstruction at the lower sigmoid and upper rectum, which were almost gangrenous in appearance. As no improvement took place after applying hot packs, it was felt that this portion of the bowel was beyond regeneration. Due to this condition

of the sigmoid and rectum, and to the inflammatory disease of the surrounding organs, a colostomy with drainage was considered the best procedure. An incision was made three inches to the left of the midline, the upper rectum and lower sigmoid were divided and

dissected free, and the stump of the sigmoid brought out and fixed in the left-sided incision.

After a stormy convalescence the patient regained good health, but was left with a terminal colostomy in the left flank. This was a source of great distress and for its relief she presented herself, nineteen months later, to the writer.

On examination at this time she presented the following essential findings. General nutrition and appearance very good. The abdomen shows a scar from the umbilicus to the symphysis, with some diastasis and herniation. There is a left-sided McBurney incision through which the terminal stump of the sigmoid opens. A barium enema given through this stump shows a complete absence of any sigmoid loop (Fig 1), the straight descending colon open-

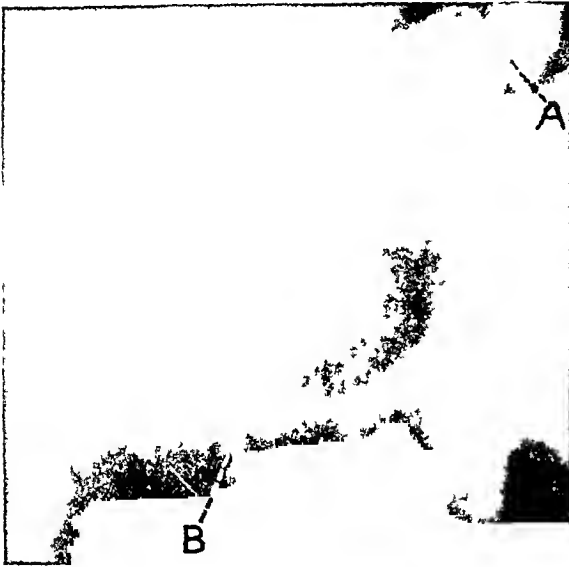


FIG 2—Stump of colon at A containing barium, and rectal tube in short pouch of rectum at B, with large defect between, due to removal of sigmoid.

ing directly through the stoma. Rectal examination showed a short rectal pouch, perhaps ten centimetres long, ending blindly. A very tender fulness could be felt above the blind end (Fig 2).

It was decided to attempt a restoration of the continuity of the bowel to the anus, mobilizing the descending colon if possible, if not, trying to bridge the defect between descending colon and rectum by interposing a loop of ileum.

Operation, January 12, 1928, Church Home and Infirmary, Baltimore, ether anaesthesia, the large midline scar, which was found to consist of nothing but skin and peritoneum, was excised. Numerous adhesions were found between the small bowel and the pelvic contents. The descending colon was explored, and found so short that its mobilization was considered inadequate to permit it to reach the bottom of the pelvis. After separation of further adhesions a large cyst of the right ovary about the size of an orange was found filling the lower part of the pelvis. This was removed, thus permitting the rectal tube, which had been placed in the stump of the rectum from below, to be felt. It was then decided to proceed with the attempt to use a loop of ileum to span the gap between the descending colon and rectum. A point on the ileum about thirty-five



FIG 3—Loop of ileum interposed between descending colon and rectum. Lateral anastomosis at A.

INTERPOSITION OF ILEUM FOR COLON DEFECTS

centimetres above the ileo-cæcal valve was selected as being the best position for the lower end of the transplanted loop, as at this point the mesentery of the ileum was longest. The bowel was divided here between clamps and the mesentery split down toward its root so as to give a mobile attachment for the stump of the transplanted loop. The ileum was then measured upward so that a long enough loop could be obtained to reach easily from the stump of the rectum to the stump of the sigmoid. The length of the loop thus determined upon was about thirty-five centimetres.

At this level the ileum was again divided between clamps, leaving an isolated loop thirty-five centimetres long attached only by its mesentery. The blood supply in this loop was absolutely satisfactory. The two stumps of ileum above and below the free loop were turned in through purse-string sutures and a lateral anastomosis was done between them, thus restoring the continuity of the ileum. The rectum was then opened at its blind end and the rectal tube drawn up from within it. The opening in the rectum was made sufficiently large to admit easily the index finger. The lower end of the free loop of ileum was passed down over the rectal tube and attached to it by catgut stitches. The rectal tube was pulled downward by an assistant, until the stump of the ileum was invaginated into the upper end of the rectum. It was fixed in this position by seven or eight interrupted catgut stitches and the rectal tube left in place. This completed the anastomosis of the lower end of the loop of ileum to the upper end of the rectum.

The upper end of the free loop of ileum was closed through purse-string sutures and was brought over alongside of the descending colon above the terminal colostomy. Here a lateral anastomosis was done between the descending colon and the upper end of the free loop of ileum. The colostomy was not disturbed at this operation at all, it being intended to close the colostomy at a second stage. A protective cigarette drain was placed to the bottom of the pelvis and brought out through the midline incision. Openings in the mesentery made by the isolation of the free loop were closed with silk stitches to prevent loops of small bowel getting into them and the abdominal wall was closed in layers with catgut, supported by two through and through silkworm gut stitches. Patient was under anaesthesia about four hours. She left the table in good condition.

An examination of the tubo-ovarian mass removed showed a tuberculous salpingitis and an ovarian cyst. Following the first operation the patient had an irregular temperature for several weeks, sometimes nearly normal and sometimes as high as 102. During this time there was frequent vomiting and crampy pains at intervals in the abdomen, but the bowels moved well per rectum every day and there was very little discharge through the colostomy. It was felt that there was a deep abscess somewhere responsible for her fever. On two occasions openings took place in the midline incision, and discharged a certain amount of pus which was odorless and looked like tuberculous pus. On the twenty-fifth of February a large amount of pus was discharged through the vagina also. On each of these occasions there was a temporary fall in the fever, which returned again in a day or two. March 1, patient complained of some pain in the left



FIG 4.—Beginning expulsion of barium enema showing loop of ileum emptying faster than colon

HARVEY B STONE

flank and March 3, a definite abscess here was opened under ether, and a considerable amount of pus evacuated. This abscess seemed to be entirely extra-peritoneal. At the same time the colostomy opening was detached from the skin through an oval incision, and turned in through a purse-string suture in an attempt to close it. The incision was packed with gauze and not sutured.

Following this operation the patient gradually improved. Temperature promptly became normal and remained so. Patient's bowels continued to move per rectum normally. Vomiting ceased entirely and so did the abdominal pain. It was quite evident that these unfavorable symptoms had been due to the deep abscess just described. The patient gained weight and was soon up and walking around. However the colostomy closure was unsuccessful. After a few days the sutures on the stump of colon cut out and the bowel re-opened. Very little drainage took place through it and as the patient had been in the hospital a long while, it was decided to let her go home with the colostomy still incompletely closed, hoping that it would close spontaneously. If this fails to take place it should prove a simple matter to close the colostomy at another operation when the patient has completely recovered her strength. (X-ray plates after operation, Figs 3 and 4)*

To capitulate briefly, a patient deprived of the whole sigmoid flexure, and existing nineteen months with a colostomy, has been restored to normal powers of defecation by interposing a loop of ileum between the descending colon and the rectum. There are a number of cases being done now in which the rectum is removed with the sigmoid when the latter is diseased. It is possible that in some instances the rectum may be preserved without prejudice to the necessary completeness of the attack on the disease. If such be the case, the method herewith presented offers a chance for the restoration of normal defecation and the avoidance of a life-long colostomy. There is a further possible utility of the same principle. Growths of the descending colon present a special problem because of notorious difficulty in securing good anastomoses between the ends. If the whole left side of the colon requires removal, either because of disease or to avoid the unsafe anastomosis of the descending colon, it would be possible to place a graft of ileum between the transverse colon and the rectum, should this prove desirable.

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* Addendum. Since this paper was written a letter from the patient announced the closure of the colostomy as being practically complete.

THE MIKULICZ OPERATION FOR RESECTION OF THE COLON

ITS ADVANTAGES AND DANGERS

BY WALTER E. SISTRUNK, M.D.

OF ROCHESTER, MINN.

FROM THE DIVISION OF SURGERY OF THE MAYO CLINIC

I ASSUME that all members of this Association are familiar with the Mikulicz operation as used for resection of different portions of the colon for carcinoma. In properly selected cases the operation may be safely performed with satisfactory results, but if it is performed in cases for which it is unsuited the mortality is high and there is a strong probability of recurrence of the malignancy in the wound or at the site of the resection. In a broad way the operation may be looked on as applicable for resection only of portions of the colon that are mobile or that may be mobilized without too great injury of the blood supply to the loop that is to be left outside.

The operation is most often used in cases of carcinoma in the sigmoid flexure and in these cases its use should be largely limited to non-adherent growths in sigmoids that have long mesenteries which will easily permit complete withdrawal, from the abdominal cavity, of the loop of bowel containing the growth. In such cases the operation, performed in four stages, may not only be done with a high degree of safety but a sufficient amount of bowel and mesentery may be removed to offer an excellent chance for permanent cure. I cannot emphasize too strongly that its use as a primary operation should be largely limited to the foregoing types of cases (Figs 1, 2, 3 and 4).

It often happens in operating that conditions are found which would contraindicate the primary use of the Mikulicz operation, and in my own experience many of the fatalities and recurrences following this operation have been in such cases.

In cases of (1) adherent growths associated with infection of the wall of the bowel and the adjacent tissues, (2) large growths associated with infection, (3) growths associated with obstruction, and (4) growths in sigmoids with a short mesentery in obese patients with a thick abdominal wall, I believe it is safer to make a slight change in the usual technic.

Adherent Growths Associated with Infection of the Wall of the Bowel and Adjacent Tissues—Most adherent growths show infection in the bowel wall and adjacent tissues, and contraction or shortening of the mesentery of the involved loop. If the Mikulicz operation is performed in four stages in such cases, the tissues surrounding the growth will necessarily be considerably traumatized in freeing the growth sufficiently to allow it to be lifted out of the abdominal wound. Such trauma probably lowers the resistance of the infected tissues and fatal peritonitis may result. The tissues thus traumatized usually pour an exudate containing virulent organisms into the abdominal cavity, which also may cause fatal peritonitis. If the mesentery is short it is difficult, after adhesions have been freed, to draw the loop out of the abdominal cavity in a manner to prevent the growth from coming in contact with the raw surfaces of the wound. If a loop of bowel containing an infected

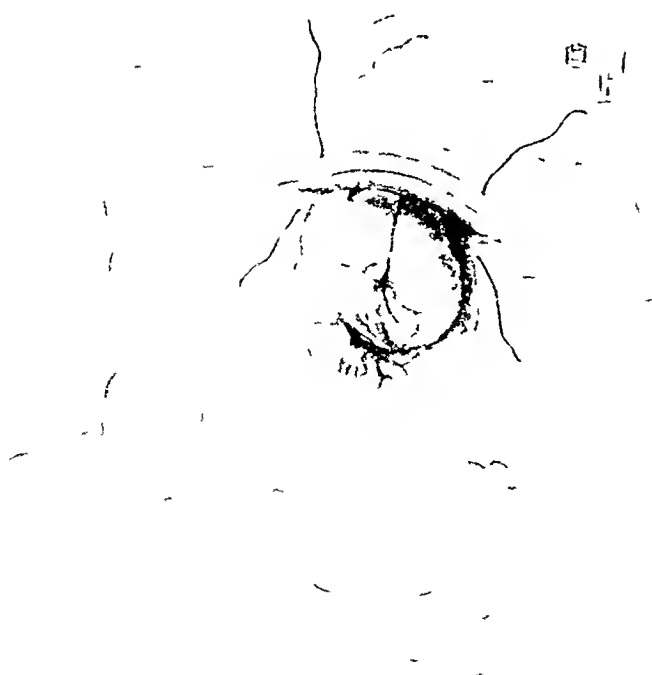


FIG 1.—Mikulicz operation for resection of carcinoma of the sigmoid. Growth lifted out of abdominal wound.

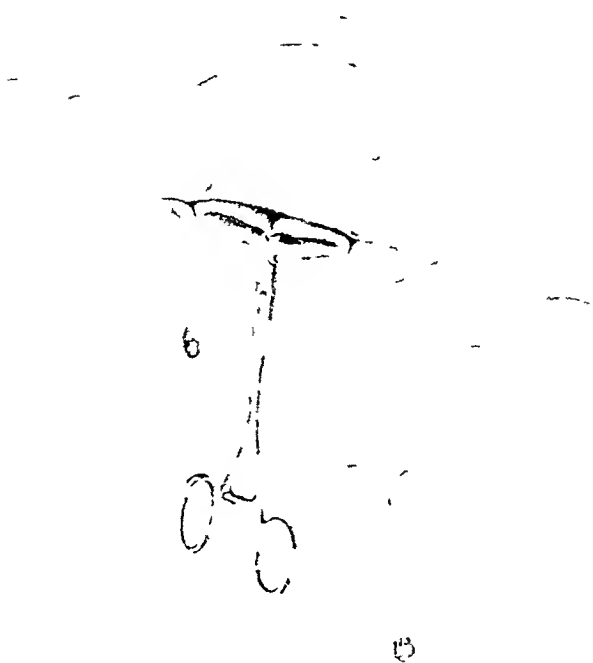


FIG 2.—Application of clamp to cut out partition between loops of bowel preparatory to closure of colostomy opening.

MIKULICZ OPERATION FOR RESECTION OF COLON

Fig 3—Appearance of bowel after partition has been cut through with clamp

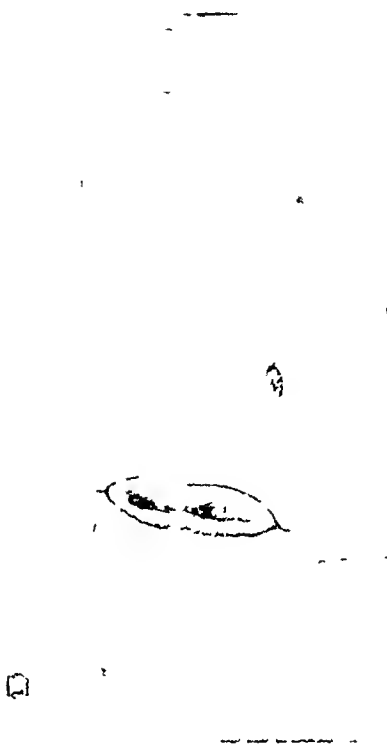


Fig 4—Fourth stage Mikulicz operation. Closure of colostomy opening. Bowel has been freed from abdominal wall without opening peritoneum, and closed transversely



growth is left in apposition with the surfaces of the abdominal wound, wound infection and possible fatal peritonitis may occur. Carcinoma cells also are likely to become implanted in the raw surfaces of the wound before the loop has been cut away, and later produce local recurrences. It may not always be possible in such cases to remove as much of the wall of the bowel and of the mesentery as is desired, and recurrence at the site of the resection is likely to develop. If the mesentery of the bowel is short, as is seen in adherent infected growths, so much tension is necessarily used to lift the loop completely out of the abdominal cavity that sloughing of the wall of the bowel through interference with its blood supply may occur, and this may cause infection of the wound.

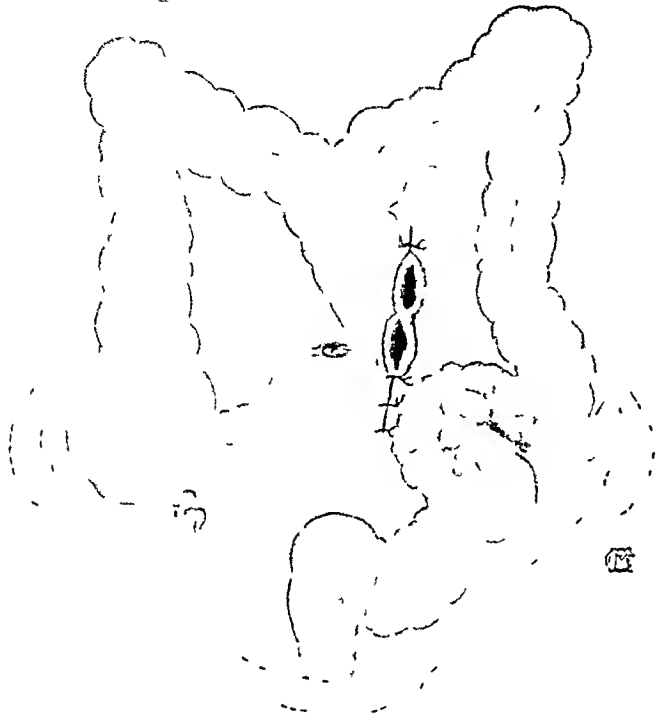


FIG 5—Colostomy in transverse colon as a preliminary to resection of adherent carcinoma of sigmoid by the Mikulicz method

completely out of the abdominal cavity that sloughing of the wall of the bowel through interference with its blood supply may occur, and this may cause infection of the wound.

Large Growths Associated with Infection—

Such growths in the sigmoid flexure are usually associated with shortening of the mesentery of the sigmoid, due either to chronic changes resulting from infection or to cedema and in these cases many of the difficulties noted in the first group are likely to follow such an operation if used as a primary procedure.

*Growths Associated with Obstruction—*Most carcinomas in the sigmoid flexure associated with obstruction are infected with virulent organisms, which also have invaded the walls of the obstructed bowel for a considerable distance. If the Mikulicz operation is used in such cases, infection of the wound or fatal peritonitis will often follow the operation. Because of the obstruction, it is usually necessary in such cases to open the bowel earlier than usual, and the soiling from such a procedure may also produce infection of the wound or fatal peritonitis.

*Growths in Sigmoids with a Short Mesentery in Obese Patients with a Thick Abdominal Wall—*If patients are obese the mesentery of the sigmoid flexure is often short and contains a large amount of fat. The subcutaneous fat of the abdominal wall in many such instances is from 6.25 to 10 cm thick. In such cases, even though the growth is small and associated with slight infection without obstruction, it is often difficult satisfactorily to lift it completely out of the abdominal wound by the Mikulicz method and the loop brought out may be left under considerable tension. The tension may seri-

MIKULICZ OPERATION FOR RESECTION OF COLON

ously interfere with the blood supply and thus cause sloughing of the bowel, infection of the wound, and possibly peritonitis

In my experience it has been much safer when operating for carcinoma of the sigmoid flexure to avoid performing the Mikulicz operation or other type of primary resection in any of the foregoing conditions, but first to perform, with as little trauma to the growth as possible, a colostomy in the transverse colon. Colostomy relieves the obstruction and no doubt, by placing the bowel at rest, decreases the virulence of the organisms in the growth and adjacent tissues. Two and a half weeks later, a second operation is performed in which the growth and as much of the mesentery as possible is resected by performing the first and second stages of the Mikulicz operation. The abdominal wall is closed around clamps left on the ends of the bowel and later the two colostomy openings which result from such a procedure are closed simultaneously (Figs 5, 6, 7 and 8)

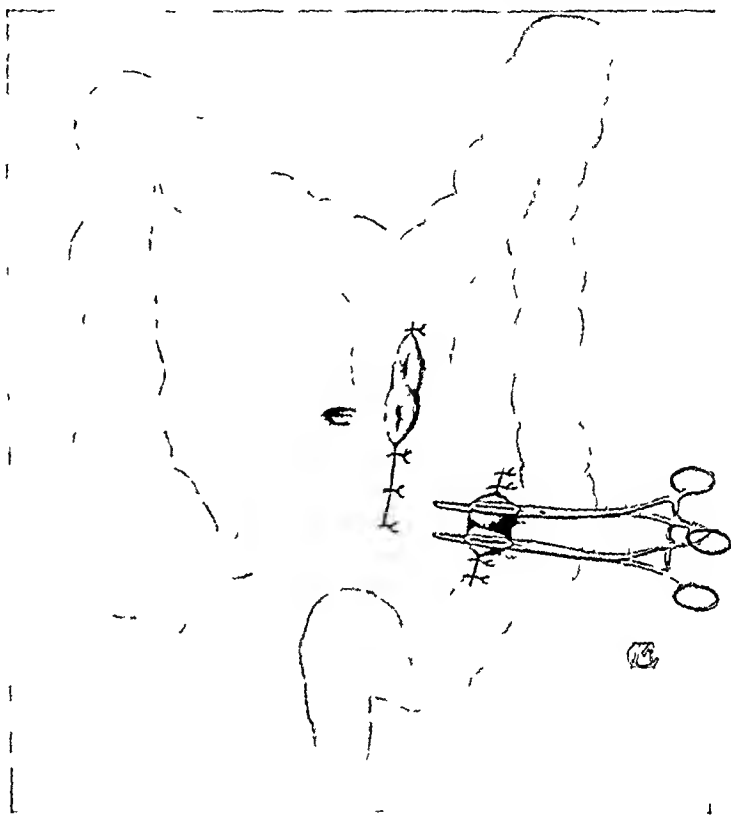


FIG 6—Same as Fig 5 after growth has been resected by first and second stage Mikulicz operation performed simultaneously. Clamps have been left on the ends of the bowel

Occasionally the Mikulicz operation may be used in resecting carcinomas in the ascending colon, but I believe that

growths in this portion of the bowel may be more satisfactorily removed by other methods, and doubt that the Mikulicz operation is often indicated in such cases

On account of the mobility of the transverse colon, the Mikulicz operation may often be used to resect carcinomas situated in this portion of the colon. In such cases it is usually easy to lift the loop of the bowel containing the tumor well out of the abdominal cavity and the four stages of the operation may be carried out with comparative safety. If the growth is very large, it sometimes seems best to perform the first and second stages of the Mikulicz operation together. Operations for tumors in this portion of the bowel are often performed through longitudinal incisions, and in this event it is necessary slightly to twist the loop of the bowel that is brought out for resection. In such cases obstruction may develop before it is safe to open the loop brought out for resection or to remove the clamps in case the first and second stages of the operation have been performed together. To obviate this com-



FIG 8 — Simultaneous closure of both colostomy openings

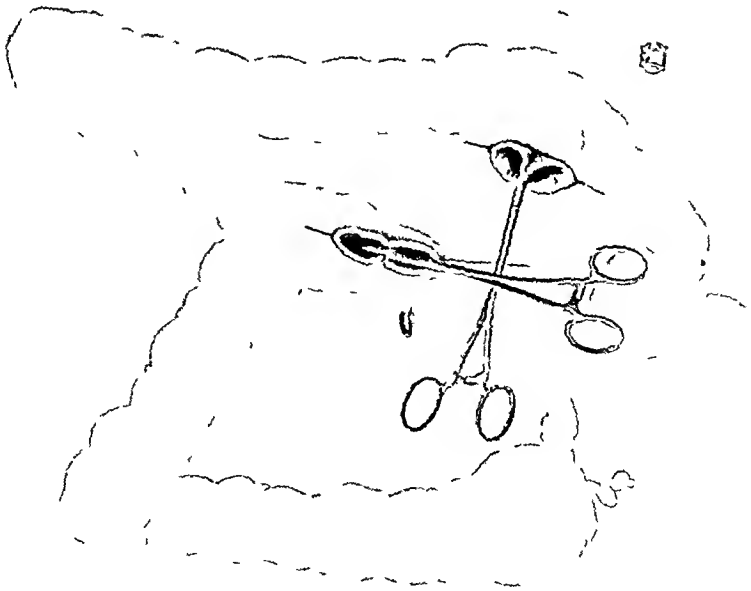


FIG 7 — Simultaneous application of clamp to both colostomy openings preparatory to closure

DISCUSSION

plication, I usually perform, at the time of the primary operation, either an appendicostomy or a cæcostomy

Small tumors in the splenic flexure with slight infection may be safely resected by the Mikulicz type of operation, if the splenic flexure is sufficiently mobilized to allow it to be completely drawn out of the abdominal wound. Appendicostomy or cæcostomy, however, should usually be performed at the same time. Large infected growths in this situation are, I believe, more safely removed either by primary colostomy in the transverse colon and later resection of the growth or by colocostomy between the transverse colon and the sigmoid flexure, and after two and a half weeks resection of the portion of bowel short circuited by this anastomosis.

The descending colon proximal to the sigmoid flexure is usually so fixed in its position, and its blood supply is such that it is difficult to make use of the Mikulicz operation for removal of growths in this portion of the bowel. It is probably best to remove them by the method which I have mentioned for resection of large infected growths in the splenic flexure.

I regard the Mikulicz operation, if judiciously used in suitable cases, as perhaps the safest known method for resection of certain portions of the colon for carcinoma. If, however, it is indiscriminately used as a routine operation, regardless of contraindications, I believe it is often a dangerous procedure which may be followed by a high mortality rate and frequently by recurrence of the malignancy.

DISCUSSION ON PAPERS RELATING TO SURGERY OF INTESTINE

DR JOHN H. GIBBON, Philadelphia, Penna., remarked as to the limitations which Doctor Sistrunk made to the employment of the Mikulicz operation. This operation undoubtedly is a safe operation, and has been the means of saving a great many lives at a time when surgeons were inclined to do resections.

The mistake is still occasionally made of resecting a large intestine in the presence of an acute obstruction, but it is not made as often as it once was. Of course there comes a time when one has to resect in the presence of an acute obstruction if there is gangrene or possibly if there is perforation. Various attempts have been made in recent years to develop an aseptic resection of the large intestine. He had tried all of them. The last six resections of the colon which he had done had been by the Kerr method. He had had one leakage and no deaths. He was convinced that it has solved the problem of immediate anastomosis. It is much cleaner than the Mikulicz operation. It means one operation instead of two or three or four. In only one of those six cases was a preliminary cecostomy done. That was done for an acute obstruction by another surgeon in another hospital. If in acute obstructions of the large intestine a cecostomy is done in order to have the opening as far away as possible from the growth, one can then later do an aseptic resection of the large intestine, getting in practically every case a primary union and no leakage. The primary cecostomy is a safety valve which is kept open until the calibre of the colon is established. He was convinced that this operation of Kerr's is the best method of resection of the large intestine that has been brought out.

DISCUSSION DR CHARLES N DOWD, New York City, said that the Mikulicz operation is one which he had worked over a good deal and had tried out under various conditions. He agreed absolutely with Doctor Sistrunk and Doctor Gibbon that the performance of a cecostomy is a great advantage where there is obstruction, and that it obviates many of the conditions under which the Mikulicz operation was at first done. However, with our present facilities for diagnosis, there are a large number of cases who have annular carcinoma of the sigmoid, or perhaps of the splenic flexure or transverse colon, on whom the diagnosis is made before they have real obstruction.

One makes an error in considering that the Mikulicz operation consists in simply drawing a loop of diseased intestine outside of the abdominal wall, securing it there and allowing it to necrose. Mikulicz used to do a good deal more than this in his later operations. His procedure diminishes sepsis and thus secures the recovery of some patients who otherwise would not recover, but it does not at all necessitate an incomplete operation.

It is not necessary to restrict oneself to a small incision through which a little loop of intestine may be pulled. One should make a large enough incision near the mid-line, when the growth is low, so that a suitable inspection of the pathological condition can be made, so that one can take out what lymph-nodes are necessary, so that one can see whether the liver has metastases in it, and so that one can mobilize the gut and then bring out the desired portion through a separate intramuscular incision in the lateral part of the abdominal wall. The danger of recurrence is no greater and no less than in other types of thorough resection.

On this basis, the afferent and efferent portions of intestine can be stitched together for a suitable distance and proper spur formation thus obtained. The likelihood of hernia is diminished, because the gut comes through a very small incision and the surrounding abdominal wall heals kindly. Temporary ligatures can be applied to the intestine at its emergence from the abdominal wall and the redundant portion can be excised, thus aiding cleanliness.

When operating on these growths of the large intestine he had usually found that there is a great deal of fat in the intestinal wall, that the peritoneum lies close to the intestinal wall only for a distance of one-quarter or one-fifth of its circumference, and that the difficulties of the other kinds of anastomosis are much increased on account of the great deposit of fat which exists around the wall, beneath the peritoneum.

His feeling was that one should not start in on the expectation of doing a Mikulicz operation, in each of these cases. It is better to start on the basis of making a suitable incision and suitable exploration and then to do whatever form of operation is indicated, being familiar with every detail that may be required for any one of them, hoping to determine the pathology and then to follow along on the basis that is needed.

He thought the Mikulicz operation properly done saves lives.

DR CHARLES L GIBSON, New York City, said that Doctor Sistrunk did not mention, and no authority that he had ever consulted or read has ever mentioned, a certain advantage about the Mikulicz operation which became

DISCUSSION

very evident to him in the first operation he ever did. This was fifteen years ago, on a gentleman who was then sixty-two and is now in sufficiently good health to preside over one of the societies which is a part of this Congress.

He had a carcinoma which had given him symptoms for about a year. At operation there was found a very typical small, tight, annular carcinoma, and a very large, loose, redundant descending colon. He was able to make a very wide dissection, loosening the loop so as to bring out a very long loop, and when the specimen was resected it was eighteen inches in length, so it would seem as if he had probably got well clear of the original disease but when the specimen was examined by a pathologist it was found that on the proximal section of the meso there were cell nests. So he kept the wound open for four months and applied to it the actual cautery once or twice a week, and evidently succeeded in getting rid of those few cell nests.

DR EMMET RYFORD, San Francisco, Cal., called attention to one danger in the matter of the Mikulicz operation that had not been mentioned in the discussion nor in the papers, and that is that often one is dealing with the so-called critical area in the matter of the circulation of the sigmoid. He found this out in a tragic way. He had performed the Mikulicz operation—this was twenty or twenty-five years ago—apparently very successfully. When it came to using the clamp to cut the spur, evidently the blood supply to the lower segment was cut, and the lower segment became gangrenous and the patient died of general peritonitis.

Perhaps one can avoid this by suitably suturing the intestinal loops together and being quite sure that in crushing them with the clamp one cuts down through the suture line instead of catching any part of the mesentery. But every once in a while one will interfere seriously with the circulation of this part of the colon in the area lying between that supplied by the inferior mesenteric and the superior hæmorrhoidal arteries.

DR HARVEY CUSHING, Boston, Mass., inquired whether Doctor Finney's patient showed any change in her blood sugar after the operation.

Doctor Finney replied that the blood sugar has been much more stable. There has not been such a wide variation, and it has been on the whole considerably higher but not very markedly.

DR WALTER E. SISTRUNK, Rochester, Minn. (in closing), approved the work of Doctor Stone in substituting a piece of small intestine for the large intestine, a procedure that offers possibilities which might be carried for a considerable distance. He had often wanted to do it but up to the present time has never had the nerve to attempt it.

Gross soiling in an intraperitoneal operation is certainly a dangerous thing. A small amount of soiling he had his doubts about. Every time one takes out appendix there is soiling. The peritoneum can handle a certain amount of soiling provided that it is not gross in character. For that reason he had never paid very much attention to an aseptic anastomosis, but he had tried always to be as careful as he could as far as gross soiling was concerned, and hoped that the peritoneum would take care of the remainder.

In his opinion, from considerable experience with it, the infections which produce fatal peritonitis come from the virulent organisms in the bowel wall and from the tissues surrounding growths. A good many years ago, before we had means of dealing with ulcerative colitis in a medical way as we have to-day, it was common in the clinic where he worked to do an enterostomy for ulcerative colitis, and in the first cases done the mortality was very high, somewhere in the neighborhood of 20 per cent. These cases were operated upon first by an exploration in which the bowel was palpated and often lifted up to look at, and the enterostomy was made by a method in which the ileum was cut completely across. The patients did very nicely for about forty-eight hours, and then a certain percentage of them went into a fulminating type of peritonitis and died. After thinking the matter over he decided that the exploration was the thing which was killing them. The trauma to the bowel caused an exudate from the peritoneal surfaces which carried with it virulent organisms.

He stopped the procedure absolutely in so far as exploration was concerned, and went in on the diagnosis which was made from the history, X-ray findings, and from the proctoscopic examination, and did an enterostomy of the same type under local anæsthesia. The mortality dropped from something like 20 per cent down to considerably below 5 per cent. Then he felt quite sure that they had traumatized this bowel and had an exudate of virulent organisms and that that was the thing which caused the peritonitis.

Shortly after that, Dr John W Draper, of New York, was discussing with him the possibility of sterilizing the colon for operation by injection of aniline dyes. He said we can inject these dyes, leave them in for thirty or forty minutes before operation, and we can really sterilize that bowel, and the pathologist is unable to grow bacteria upon it. When you operate, that dye will come through the bowel wall. If you traumatize it or rub it you will find the dye on your sponges. That absolutely corroborated what they had learned clinically.

So he had felt that the virulence of those organisms had more to do with the fatal peritonitis than any slight soiling which might come and which probably happens in every appendectomy which is done.

Personally, while it looks as though a number of procedures are necessary in using an operation of this sort, one must consider that operations for resection of the colon are certainly dangerous operations and carry probably a mortality which is as high as any of the intraabdominal work which is done. Any factor that we can use which would tend to diminish mortality should be used. The question as to whether or not we delay a patient two weeks or two and a half weeks, or whether we do three operations instead of one, is to be very gravely considered, because if we try to clean everything up at one operation and get through, the mortality is certainly going to be very much higher than it is if the intestine can be placed at rest by a colostomy which stops all bowel movements, and by allowing a period of two and a half weeks before attempting a radical procedure.

INTRATHORACIC DERMoids

WITH THE REPORT OF A CASE OF TOTAL EXTIRPATION AT ONE SITTING
BY A NEW METHOD OF THORACOTOMY

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AND

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OF WASHINGTON, D C

A REVIEW OF THE LITERATURE OF THORACIC DERMOID TUMORS

In an exhaustive study of the literature, 138 cases of thoracic dermoid tumors have been collected and herein summarized, including the author's case. This number of reports is greater than recent writers have reported. The majority of these growths were intrathoracic, and a few bulged into the neck, seven were found in the thoracic wall. Many of the case reports are incomplete and sixteen of them consist only of brief necropsy findings.

Etiology—The genesis of these growths has not been definitely proven, although numerous hypotheses have been advanced. Ewing states that a single origin through a one-sided development of teratomata cannot be excluded for the entire group. The most generally accepted view seems to be that these dermoids are the result of fetal inclusions, the teratoma representing an early cell inclusion and the simple dermoid a later stage in the germinal differentiation. Some authors state that these tumors arise from ectodermal displacements pulled down into the chest by the descent of the heart or by some abnormal displacement of cells from one or the other of the branchial clefts. Another conception is that a blastomere is displaced in the course of development, and upon the development of this displaced cell depends the type of tumor which results.

Wilms concludes that dermoids of the head, chest and many of those of the retroperitoneal tissue are produced by abnormal development of germinal tissue with invagination of the epithelium to form glands, or by a growth of fetal fission cells, and he regards the intra-abdominal teratoma as a fetus in fetu.

Presternal dermoids may result from imperfect closure of the anterior chest wall. Bergmann observed a dermoid divided into two compartments by the sternum but joined by a canal through the bone. In Bird's case a projection of the tumor dipped down between the manubrium and gladiolus sterni. A traumatic origin is unlikely though it has been demonstrated for both dermoids and epidermoids in many regions. From the varied pathology and location of these tumors, it is probable that a single origin would not apply to the entire group.

The infrequency with which thoracic dermoids are encountered is indicated by the number of case reports from that of Gordon's in 1825 to the present. Undoubtedly some cases have either been overlooked or not reported.

Certainly many symptomless intrathoracic tumors, probably dermoids, are discovered in routine X-ray examinations of the chest and are not reported in the literature. One of us has seen at least a half a dozen such cases. Generally speaking and in order of frequency these neoplasms occur in the ovary, testicle, sacro-coccygeal region and mediastinum.

All authors have found that the greater number of cases have been observed between the ages of twenty to thirty years. The youngest cases are in infants. Medoei reported a cyst in a suckling, Medvel noted a cyst in a nursing, and Cahen observed a cyst in an eight months' old child. The oldest case was that of a cyst in a woman sixty-two years of age, reported by Fawcett.

The sex has apparently no influence and was about equally divided. There were fifty-nine reported in males, sixty-two in females, and in seventeen the sex was not stated.

Age	No of cases	Sex			Type of tumor		
		M	F	?	Cyst	Teratoma	?
Under 1 yr	3			3	3		
1-10 yrs	8	3	5		5	3 (1 mal)	
10-20 yrs	26	11	15		14	11 (2 mal)	1
20-30 yrs	43	20	21	2	37 (1 mal)	6 (1 mal)	
30-40 yrs	23	10	13		21	2 (2 mal)	
40-50 yrs	7	5	2		5	2 (1 mal)	
50-60 yrs	6	3	3		5		1
Over 60 yrs	4	2	2		4		
Unknown	18	5	1	12	11 (1 mal)	6 (3 mal)	1
	138	59	62	17	105 (2 mal)	30 (10 mal)	3

In only eighteen cases was the occupation noted and these were of the middle and lower walks of life. Of the total 138 cases studied fifty-three were German, twenty-six American, nineteen English, fourteen French, eleven Russian, six Italian, one Swede, one Armenian, one Hindu, one Belgian, and five unknown.

Symptomatology—There is no characteristic symptom complex of this disease as the symptoms are those which may accompany many intrathoracic affections. The only pathognomonic symptom is that of coughing up hairs. The disease usually can be divided into a latent and active period of variable duration. Occasionally one or the other of these stages may be missing. In other words the latent period, during which the growth gives no evidence of its existence, may continue throughout life and the tumor be accidentally found at autopsy. Again, the active stage, during which symptoms are present, may begin early in life and even at birth. The onset and course of the disease varies and were first divided by Dangschat into three groups: 1. Most frequently, the onset is insidious with a gradual increase in the severity of the symptoms. 2. The beginning may be similar but later followed by sudden development of severe and sometimes fatal symptoms. 3. Least

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often, the onset may be acute with great severity and the further course of the disease terminate early and fatally or assume a chronic character. Alternating periods of remission and exacerbation of symptoms have occasionally occurred.

The ages at which symptoms began are tabulated as follows

At birth	1-10	10-20	20-30	30-40	40-50	50-60	60-	Unknown
5	9	28	27	13	4	3	1	48

The onset in twenty-two cases was marked by some disease, injury or operation. Some writers claim that puberty usually denoted the beginning of symptoms, for the tumor at this time takes on a sudden rapid development. This may be true in a few instances but it is certainly not the rule as proven by the above table. The onset followed pneumonia in five cases, pleurisy in five, trauma in four, influenza in one, catarrhal infection in one, scarlet fever in one, typhoid fever in one, labor in one, weaning a child in one, and an abortion in one.



FIG 1—X ray of chest taken September 18, 1924, when the tumor was first discovered

The most common initial symptoms and signs present were sense of pressure or pain, localized or referred, (thirty-eight cases), cough with expectoration (thirty cases), and dyspnoea (twenty-eight cases). These three were frequently associated together at the onset. Other less common initial symptoms were, tumor of the neck in eight cases, hæmoptysis in four, tumor over the sternum in six, pleural effusion in four, fever in four, fatigue in two, coughing hair in one, fistula in the neck in one, abscess of the back in one, bulging of the chest in two, dysphagia in one, cyanosis in one, hoarseness in one, asthmatic attacks in one, vomiting in one, chills in one, cardiac palpitation in one, defective vision in one, coryza in one, and the fact that the left shoulder was higher than the right in one.

Hertzler divides the symptoms into two groups, those due to 1, pressure, 2, irritation from the tumor. He suggests that the irritation is caused by some chemical changes of the increasing amount of the cyst contents, and in this way these growths may imitate the life history of wens. Such irritative symptoms as pleurisy, pleural exudates, pneumonitis, etc., may give rise to incorrect diagnoses.

In forty-three cases the symptoms were not given. Dyspnoea, cough and pain were also the most common persistent symptoms. Dyspnoea occurred in fifty-nine cases and varied in severity. Usually it became more intense with the growth of the tumor, though occasionally it was paroxysmal, or severe at the onset, or marked by remissions of normal breathing.

Cough was noted in fifty-five cases, forty-three with expectoration, five without and unstated in seven cases. This like the dyspnoea was sometimes paroxysmal. The quantity of the expectorated matter in six instances was noted as copious. The quantity may increase with the course of the disease and sudden increase of the amount may denote rupture of the cyst into a



FIG. 2.—X ray of chest taken May 11, 1925, showing the gradual increasing size of the tumor.

bronchus or lung. The character of the sputum was muco-purulent in five cases and of a dark brownish color in three. Hæmoptysis was present in nineteen instances and varied in amount. Occasionally it was so severe as to cause exitus. The cough produced pain in the chest in one case. Hair was present in the sputum in twelve instances. Its presence means a communication between the cyst and a bronchus or lung. Such communication was found at autopsy sixteen times and the absence of this symptom in the remaining four cases may be explained by the fact that the hair was rolled into a ball-like mass that was too large to pass through the opening. In six cases the odor of the sputum was foul and might lead one to suspect bronchiectasis or pulmonary abscess.

Pain was present in fifty-one cases. It usually was described as a dull ache or sense of pressure or tightness in the chest and occasionally it was sharp, severe or acute. It also may be paroxysmal. In one case it was distinctly worse at night. In fourteen of these reports the pain was referred to the location of the tumor, intercostal region, shoulder, back, ear, back of the head, infra-clavicular region, abdomen, or arm of the affected side.

Fever occurred in twenty-one cases and was of a low grade type unless there was some complication or intercurrent disease.

Other symptoms were: Cyanosis seventeen cases, elevated pulse sixteen, rapid respiratory rate eleven, chills five, dysphagia four, vomiting three, headache four, œdema of the feet eight, ascites two, general anasarca one, night sweats two, diaphoresis one, palpitation four, orthopnoea one, coryza one, abdominal pain one, fistula in the neck one (Bastianelli), fistula in the

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chest four (Koerte, Beigmann, Belin, Goebel and Ossig), clubbing of the fingers five (Godlee, Ekehoim, Whittemore, Fawcett, Shaw and Williams), clubbing of the toes one (Fawcett), hoarseness or changing voice three (Griffin, H Smith, Morone), impairment of speech one (Black and Black), numbness of the right hand one (Shostak), and defective vision of the left eye one (French)

Findings on Examination—No examination was made or no findings reported in fifty-four cases and examination of the patient was negative in four instances. The findings noted were mainly the unusual ones. Emaciation or cachexia in seventeen cases, distention of the superficial veins in ten, inequality of the radial

pulse in two (Cordes, Becker and Carey), unequal pupils in five (Marfan, Kraus, Murphy, French, Smith and Stone), ptosis of the left eyelid in two (Murphy and French), laryngeal changes in one (Kraus), left vocal cord paralysis in one (H Smith), œdema of the nearest arm in two (Ceelen, Becker and Carey), scoliosis in four



FIG 3—X ray of chest, September 7, 1926, when the tumor had almost reached the lateral chest wall and first showed lobulation

(Murphy, Nandrot, Von Torok, Payr), and kyphosis in one (Payr). Murphy's patient in addition to unequal pupils, ptosis of the left eyelid, distention of the superficial veins, and curvature of the cervical spine to the left also presented a spastic ataxic gait, choreoform jerkings and decreased motor power of the left arm, rigidity of the neck and sensory disturbances. French reports that the individual could not blush and did not perspire on the left side of the face in addition to having ptosis of the left eyelid, a smaller left pupil and distention of the superficial veins. Becker and Carey noted tenderness over the sternum and œdema of the left side of the face besides œdema of the left arm, distention of the superficial veins and inequality of the radial pulses. Enlarged lymphatic glands were observed in the neck in two instances (Griffin, Edelman), in the axilla in one (Griffin), and in the supra-clavicular region in one (Cahen). Two of these cases presented malignant degeneration of the tumor.

A swelling or bulging of one side of the neck was seen in fourteen cases, seven of which were fluctuant and three transmitted a pulsation but this was never expansile. Pohn reported a bilateral tumor of the neck and Hertzler a midline tumor above the sternum. A unilateral bulging or fullness of the chest was mentioned in thirty-seven reports, three of which were fluctuant

(Mandelbaum, Von Tork, Kleinschmidt) A tumor over the sternum was present seven times (Selby, MacEwen, Clutton, Cahen, Calvalcanti, Morestin, Bud), three of these fluctuated. In two cases there was a sinus in the chest and in another in the neck (Morestin).

Palpation revealed a diminished expansion of the affected side of the chest thirteen times and decreased or absent tactile fremitus over the growth eighteen times.

By percussion over the tumor there was relative or absolute dullness noted in fifty-four instances.

Auscultation over the growth gave distant or absent breath sounds in forty-one cases, decreased or absent voice sounds in fourteen, a friction rub in two, increased voice sounds in one, tubular or bronchial breathing in six, and moist or dry râles in eighteen. The physical signs of a cavity due to emptying a perforated cyst have never been observed.

The heart was displaced to the left in fifteen instances, to the right in eleven, and downward in one. Pericardial effusion was present in two cases (Cordes, Kavanagh).

The liver was displaced downward in fourteen instances, the tumor being in the right hemi-thorax.

Röntgenological Studies—X-ray or fluoroscopic examination was made and of diagnostic value in thirty-five patients. In Morone's patient it was reported negative. Hale noted pulsation of the tumor on fluoroscopy but this case was later studied and operated by Lilienthal who could not confirm the finding. The neoplasm usually gave a definitely outlined shadow but sometimes its shadow was continuous with that of the heart. To demonstrate teeth or pieces of bone in the growth is possible and practically diagnostic. Bone was shown in this way in Smith and Stone's patient and calcified deposits seen by Kleinschmidt and Goebel and Ossig. None of the röntgenologic studies report infiltration of the surrounding lung or mediastinal structures. A pneumo-peritoneum with carbon dioxide gas was performed by Moons to exclude any abdominal origin of the tumor. Examination following intra-tracheal injection of lipoidal has never been reported except in the author's case. It is of value in determining the degree of pressure on the bronchus and the possible presence of a communication with a bronchus.

Bronchoscopy—A bronchoscopic examination was made in three cases (Lilienthal, Hamman, H. Smith), and apparently was of diagnostic assistance in the last case. It might help inform one of the location of the growth or of the degree of pressure or irritation of the bronchial tree. The possibility of emptying a communicating cyst by this method has never been reported.

Laboratory Studies—Of these, microscopic examination of the sputum and of the fluid obtained by aspiration of the tumor are most important. The former aided in the diagnosis in four cases, excluding the gross presence of hair in twelve and blood in nineteen instances. Epithelial cells, especially those resembling the horny layer of the skin, fat droplets and cholesterol crystals were found in the expectorated material. In a few cases smears were

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made to rule out other infectious lung diseases. In forty-three cases aspiration of the tumor was attempted and examination of the obtained material of value in nineteen. Culture of this fluid was negative in six instances. The gross and microscopic findings of aspirated material are similar to those sometimes found in the sputum. Blood studies are of no direct diagnostic assistance except in the presence of some complication or malignant degeneration of the tumor. Whittemore reported a leucocytosis and French an eosinophilia.

Morbid Anatomy—The various names applied to these neoplasms designate their pathologic structure: dermoid, epidermoid, teratoma, embryoma, fetus in fetu. We have divided them into (1) dermoid, (2) teratoma. The dermoid cyst consists of skin and its appendages and sometimes cartilage, bone and teeth. In this group are included the epidermoid tumors in which definite dermal structures are wanting. The teratoma contains derivatives of all three germ layers, ectoderm, mesoderm, and endoderm. The true embryoma and fetus in fetu should closely resemble an embryo or rudimentary fetus and strictly speaking

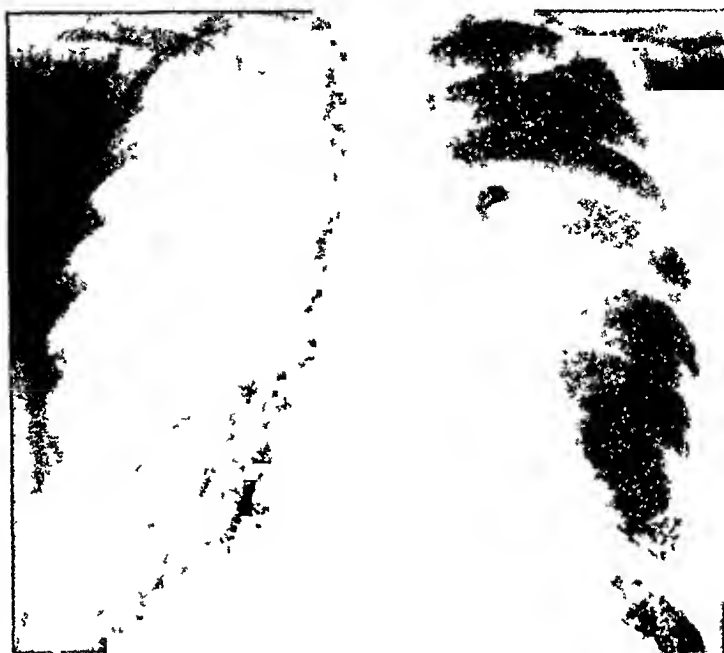


FIG. 4—X ray of chest taken March 14, 1927, after an injection of lipiodal. In the plate the angulation and constriction of the left bronchus can be seen.

these have not been reported in the thoracic cavity. However, Prym reports in an eleven-year-old girl a "dermoid cyst" of the anterior mediastinum which, in a solid part, contained maxilla-like formation with teeth. The histological examination revealed different components which, as a whole, correspond to the cephalic pole of an individual.

There were 105 dermoid cysts, thirty teratomata, and three tumors of undermined pathology. Sixty-four autopsies were reported and ten deaths without autopsies besides the total or partial specimens examined after operative removal.

Located in the anterior mediastinum were forty-three tumors, in the posterior mediastinum one (Foa), in the right hemi-thorax forty-seven, in the left forty, directly behind the sternum ten, in front of the sternum seven, at the bifurcation of the trachea one (Ceelen), in the right lung two, in the left one, on the pulmonary artery within the pericardium one (Joel). In three cases the location was not stated. Naturally many of the tumors reported in the anterior mediastinum also extended into one or the other side of the

thoracic cavity The greater majority of these tumors evidently originated in the anterior mediastinum and extended into either side of the thorax from some unknown cause, possibly the forces the surrounding structures exerted upon the tumor or the fact that one portion of the growth developed more rapidly

The size, weight, shape, color and consistency of these neoplasms vary markedly The size ranged from that of a walnut and pigeon egg to those which fill one side of the thorax Some were accurately measured, in others the cyst contents were measured, and in many various descriptive terms, such as a child's head, cantaloupe, grapefruit, man's fist, apple, cocoanut,



FIG 5—X ray of chest taken June 25, 1927 Eleven days after operation, showing the complete pneumothorax

tangerine, goose egg, hen's egg, etc, were used In Foucher's case the cyst contained 2 to 3 litres and in Schlier's four quarts The size of the growth should be considered with that of the individual for comparatively enormous tumors have been reported in children Of the few recorded weights the heaviest was 4750 gms (Christian) and the next 4300 gms (Becker and Carey)

The shape has been described as globular, spherical or round, lobulated, nodular, uneven, etc In a very few the color was given as gray, white, pink or combinations of these One was described as gray with pink and red areas Though the wall of the cystic tumors is opaque, the color sometimes might depend upon its contents or hæmorrhage into the cyst The consistency was not mentioned but varies with the type of tumor and its contents

There were sixty-nine single cysts, thirty-four multilocular and eight multiple ones In the remaining twenty-seven cases this was not stated or the tumor was solid Often a single cyst contained a solid portion in its wall

The neoplasm was practically always adherent to the neighboring tissues which may be any structure within the chest Seldom is it fastened to but one structure Adhesions to cervical tissues are quite common when the growth has extended upward into the neck The nature of the adhesions vary from thin, filmy or fibrinous ones which are easily separated to very firm, fibrous ones where no definite line of demarcation can be made out In Mouat's case the cyst consisted of two parts extending from the thyroid to the diaphragm and partly divided by a band The cyst wall inseparably

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blended with the pericardium. The upper part of the cyst was the size of an orange, irregular and its projections pressed upon the innominate vein and artery, vena cava, aorta, pulmonary vessels, left carotid artery, thymus, trachea, vagus, and phrenic nerves. The character of these adhesions does not so much depend upon the size of the tumor, but rather upon the irritation of the neighboring tissues produced by the tumor. The growth was adherent to the lung in fifty-nine cases, the pericardium in forty-two, chest wall in thirty-two, diaphragm in eighteen, the great vessels in twenty-one, trachea in seven, thymus in six, œsophagus in three, thyroid in two, vertebræ in one, and the vessels in the neck in one. Joel reports a teratoma attached to the pulmonary artery within the pericardium but the lumen of the artery was patent.

Most uncommonly a cyst may perforate a bronchus or lung and totally or partially empty its contents. A communication with a bronchus was observed in fourteen cases and with a lung in four. The tumor had perforated the skin once (Koerte), the aorta once (Buchner), and the pericardium twice (Cordes, Perves and Oudard). In Korner's case the growth had eroded the sternum until there was an opening the size of a lead pencil through the bone.

In a few instances the lung was so pressed into one portion of the thorax that it had atrophied or become atelectatic. Whittemore states the right lung was pushed into the apex of the chest and its appearance so changed that its identity was assured only by recognizing the lobes. It would not expand after the removal of the tumor. McArthur and Hollister also report atelectasis of the lung from neoplastic pressure.

Many kinds of tissue and semi-liquid material were found in the contents of these dermoids. Hair was reported eighty-four times and the absence of hair mentioned eight times. The hair was sometimes attached to the inner lining of the cyst, or on polypoid masses, or found singly, or in balls or masses of different shapes embedded in the cheesy contents. The color of the hair usually did not correspond to that of the individual and occasionally was very fine and downy. Sebaceous or fatty material occurred in seventy-nine cases, pus in ten, myxomatous fluid in two (Whittemore, Smith and Stone), gelatinous fluid in two (Carpenter, Joel), colloid material in one



FIG. 6.—X ray of chest taken August 1, 1927, about six weeks after operation, showing the beginning expansion of the lung.

(Christian, 1907), serous fluid in one, and a mucoid substance with brown grains in one (Lilienthal). Mixed in with these liquid and semi-liquid substances were epithelial cells usually of the stratified pavement variety in thirty-three cases, cholesterol crystals in twelve, red blood cells in five, and frequently fat droplets. Striated muscle tissue was present in the contents in two instances, lymphatic tissue in two, and a portion of spleen and intestinal wall in one (Pohl). Pieces of bone occurred fifteen times, cartilage seventeen, and teeth eight. These latter structures were often associated together though not always. The bone and cartilage assumed irregular shapes though in Gordon's case the bone resembled an upper maxilla and Prym found a



FIG. 7—X ray of chest taken October 21, 1927 showing the lung almost completely expanded and the diaphragm descending

maxilla-like formation with teeth. The number of teeth varied from one to seven, Bergmann found four and Gordon reported seven. The shape or kinds of teeth were not stated. The contents of these tumors also showed calcareous or calcified material five times, atheromatous four, and concretions twice. Polypoid projections covered with epithelium were found in twenty-four instances and occasionally grew hairs. The polyps sometimes were so numerous as to fill the cystic cavity and when removed gave rise to serious hæmorrhage or recurred.

The wall of these growths varied considerably in thickness and structure. The thickness of the wall was not usually uniform. Nandrot reports one of 3 mm thick, Beye one of 1 cm, and Caldbick one of 3 to 6 cm. The structure of the wall often showed the same variety of tissue as found in the contents. Epithelium resembling skin or mucous membrane was present in sixty-four cases, ciliated in fourteen, glandular in six, intestinal in four, retinal in two, liver in two, and thyroid epithelium in one. The absence of epithelium was mentioned by Marfan. Hair follicles were reported nineteen times, sebaceous glands twenty-seven, sudoriferous glands twenty-one, mucous glands four, salivary gland tissue two, connective tissue ten, nerve or ganglion cells sixteen, lymphoid tissue seven, smooth muscle eighteen, striated muscle eight, fat tissue three, colloid material two, blood cells six, free blood two and pancreatic tissue one. The tumor wall also contained cartilage in twenty-three instances, bone in fourteen, teeth in two, and calcareous or calcified areas in seven. Sieber found derivative organs of the intestinal tract and Payr's case showed a section of large intestinal wall.

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Secondary changes in the neoplasms are not uncommon and include papillary ingrowths, overgrowths or dermal structures, rupture, suppuration, and malignant changes. These except the last have been previously mentioned. Malignant degeneration was found in twelve cases (ten teratomata and two cysts). Sarcomatous changes occurred in seven, carcinomatous in six, and chorio-epitheliomatous degeneration in one (Ritchie). The cases of Virchow and Warthin presented both sarcoma and carcinoma. Chorio-epithelioma development in teratomata is seen most frequently in the testicle (Warthin, Frank). There were metastases in the liver in five of the twelve cases, in the lungs in three, pleura in one, sternum in one, ribs in one, spleen in one, mediastinal lymph glands in two, supra- and infra-clavicular glands in one, and axillary glands in one. The type of metastases was mentioned in five reports and was identical with that of the original tumor.

Adenopathy of the mediastinal lymph-nodes reported in three instances was due to malignancy twice and infection once.

Intercurrent Diseases and complications—A

great variety of conditions were reported, some of which caused exitus. The most common were perforation of the cyst, pneumonia, and pleural effusion. Perforation as heretofore mentioned was present in twenty-three instances. Lobar or broncho-pneumonia occurred in eleven cases and in one of these peritonitis was associated. Pleural effusion was present eleven times, the fluid was usually yellowish but hemorrhagic twice. Malignant disease developed in twelve cases. Pulmonary tuberculosis was given in nine instances and in another tuberculous peritonitis and enteritis occurred (Marfan). The other complications reported were empyema five times, secondary post-operative hemorrhage five, post-operative febrile reaction three, pericardial effusion two (Cordes, Pohl), pericarditis two (Christian, Goebel and Ossig), bronchiectasis two, one was bilateral (Sormani, Ekehorn), pneumothorax one (Turk), hydro-pneumothorax two (Kavanagh, author's case), infection of the cyst three (Payr, Davies, McArthur and Hollister), pyemia one (Godlee), sepsis one (Smith and Stone), toxemia one (Mandelbaum), ascites (Mouat), cardiac enlargement with thrombosis of the left subclavian and left internal jugular vein (Ceelen).



FIG 8—X ray of chest taken on April 3, 1928, showing the complete disappearance of the pneumothorax, descension of the diaphragm and the beginning of the lung shadow.

Diagnosis—The diagnosis is not easy and many cases were mistaken for other conditions before operation or exploratory puncture. The entire picture of the disease must be taken into account, for the variation of the symptoms, signs, and behavior of the tumors, and the presence of intercurrent diseases or complications offer many diagnostic difficulties. Expectoration of hair is pathognomonic and the definite signs of a solid intrathoracic mass should arouse one's suspicion. Examination of the sputum, X-ray and fluoroscopic study, bronchoscopy, and the ineffectiveness of treatment other than surgical may sometimes be of considerable assistance. Exploratory puncture is valu-



FIG. 9.—Photograph taken ten days after operation, exhibiting the incision. No dressing or support was necessary and post operative calisthenics were instituted at this time.

able. This was done in forty-three cases and in nineteen of these examination of the aspirated fluid was of diagnostic aid. The important findings in this fluid and in the sputum have already been referred to. Puncture of the tumor should be done with a long needle of wide lumen or a trocar attached to an aspirating apparatus. Fluoroscopy is an ideal guide in this procedure. In some instances diagnostic incision is necessary and should be done if there is sufficient indication.

The many problems of differential diagnosis will not be discussed at length except to mention some of

the mistaken impressions that were reported. An incorrect diagnosis of empyema was made seven times, pleurisy four, pleural effusion three, pneumonia three, hydatid cyst three, pulmonary tuberculosis two, tuberculous mediastinal adenitis one, central abscess of the chest one, lung abscess one, bronchiectasis one, aneurism one, caries of the rib one, goitre one, asthma one, cold abscess one, actinomycosis one, streptothricosis one, and atheroma one.

Other conditions which might cause confusion are benign tumors as lipoma and fibroma, persistent enlarged thymus, malignant disease, pericardial effusion, syphilis, and lung calculi.

Duration—The duration of the condition more commonly lasts from two to five years. In five cases it existed practically throughout the lifetime of

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the individual (eleven, seventeen, twenty-two, twenty-four, and twenty-nine years) The longest duration was forty-five years

Duration	1-4 wks	1-3 mos	3-6 mos	½-1 yr	1-2 yrs	2-5 yrs	5-10 yrs	10-20 yrs	Over 20 yrs	45 yrs	Un- known
No of cases	7	7	1	11	10	24	17	6	3	1	51

Prognosis—The outlook depends upon many factors, the size, location, rapidity of growth of the tumor, the number and severity of symptoms present, the general health or physical condition of the individual, and the possibility of complete extirpation of the tumor In the majority of cases the patient's life is sooner or later endangered unless the tumor is removed or its development curtailed In a few instances the individual has suffered but few or no symptoms for many years and death was due to some other cause The cause of death in either operated or unoperated cases has been one of the above-mentioned complications

Treatment—The treatment is surgical Medical, anti-syphilitic, and X-ray or radium therapy are useless except occasionally as a means of differential

diagnosis Kahn's case was given seven radium treatments without results and later operated upon The first case to be operated was in 1871 when Pohn incised and drained a dermoid protruding in the neck The ultimate result was not stated Complete extirpation was first performed in 1893 by Bastianelli who resected the manubrium after three previous excisions of a fistula A permanent cure followed The type of operation and method of approach are determined by the size and location of the neoplasm and its adherency to neighboring structures

Operation should be recommended in the majority of cases, but not in all, for in a few the tumor has remained dormant without symptoms throughout lifetime Such cases have been reported on finding the growth at



FIG 10.—Photograph of the tumor, showing the collapse of the more recent lobule of the cyst into which is seen the projecting finger like process covered with fine hair and normal skin

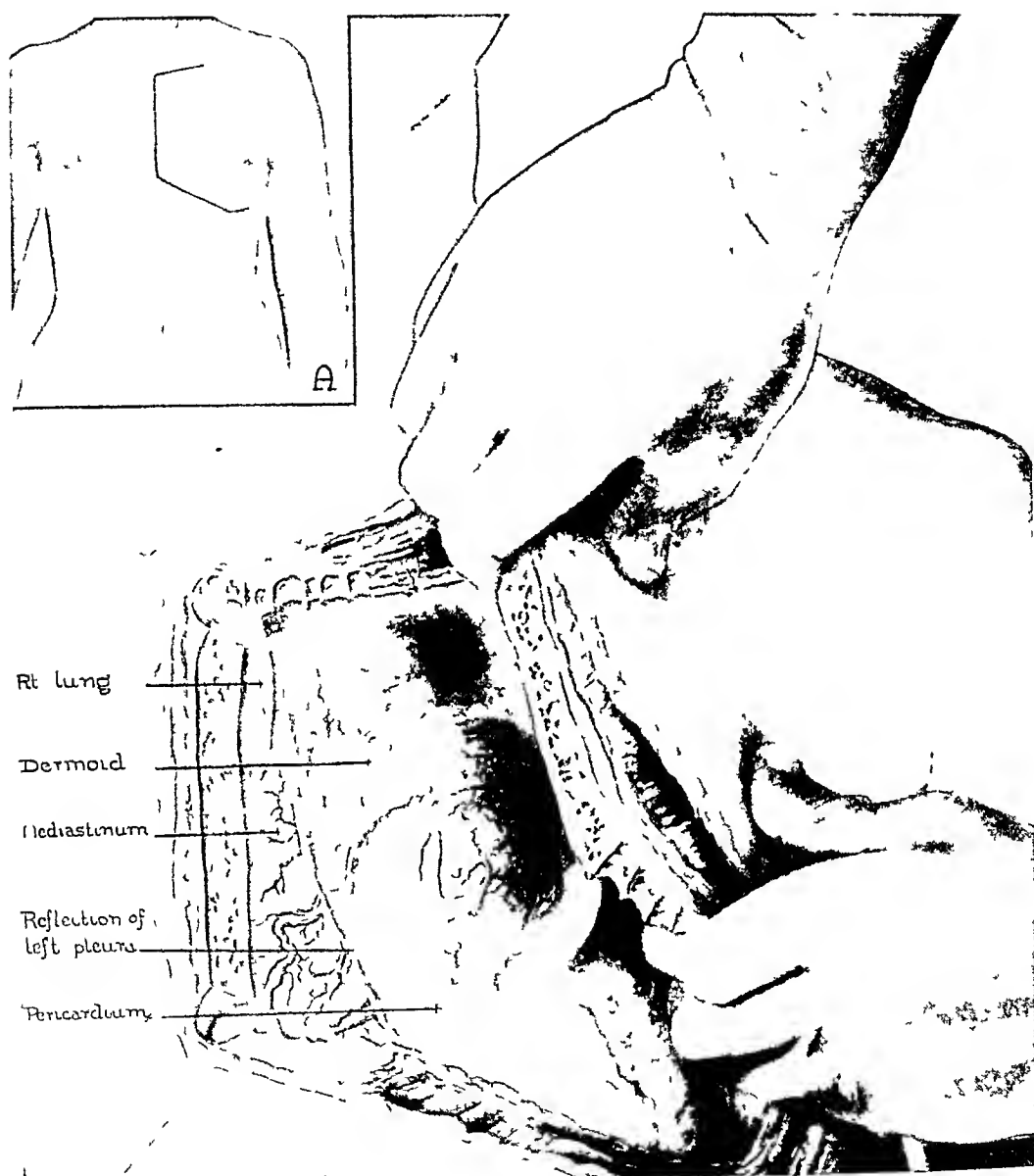


FIG 11—A new method of thoracotomy showing bevelled incision of the sternum into the first and sixth interspaces allowing the left half of the sternum with the ribs to be sprung open in the form of a trap door which gives complete access to the entire hemithorax. The thoracotomy gives ideal exposure for any intrathoracic manipulation as it exposes the mediastinum, pericardium and hilus of the lung

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necropsy These latent tumors might be accidentally picked up by routine examination or X-ray and it is unwise to submit these individuals to the risks of thoracotomy

The palliative surgical procedures are aspiration, incision and drainage with or without partial removal, and decompression Obviously the only curative procedure is complete extirpation Aspiration was done in forty-three cases mostly for diagnostic purposes, but gave partial relief of symptoms in seven instances As much as 400 cc and 700 cc have been withdrawn (Caldbeck) Becker and Carey aspirated 3 litres and Carpenter 13½ ounces of pleural fluid with relief Decompression alone was not reported Senn made an opening through the sternum but did not find the tumor This opening however was not of sufficient size to decompress the tumor The following table denotes the type of operation, number of sittings and results reported

	Incision and drainage	Complete extirpation	Totals
1 stage oper	28	17	45
2 stage oper	9	8	17
3 stage oper	4	2	6
4 stage oper	0	3	3
10 stage oper	1 (Shaw, relieved)	0	1
17 stage oper	0	1 (Davies, cured)	1
Cured	0	28	28
Relieved	20	0	20
Unchanged	1 (Senn)	0	1
Result unstated	2 (Pohn, Koenig)	0	2
Deaths	19	3	22

Local anæsthesia was reported used six times and general fourteen Whittemore attempted paravertebral injection in vain Morris advises the use of chloroform in preference to ether because of the constant and prolonged bronchitis frequently associated with these tumors A local anæsthetic might be used in a few instances where the growth is easily accessible A general anæsthesia of gas and ether is preferable in the majority of cases when the thorax and possibly the pleura are opened, for during closure, if drainage is not indicated, the lung can be insufflated and restored as nearly as possible to normal function

The cystic tumor or resulting cavity after removal was drained in forty-eight cases, the pleura in three, and the pericardium in none In but two cases was it definitely stated that drainage was not employed The cyst ruptured during operation in five instances (Naegeli, Selby, MacEwen, Bird, author's case)

The length of time between the first and final sitting varied from four days to five years In twelve cases this interval was within a year, in five cases within two years and in Madelung's patient five years for two stages Davies reported a cure after seventeen sittings within two years

Several operators have attempted the use of chemicals to destroy the cyst

lining Lilienthal tried a solution of 10 parts zinc chloride, 10 parts copper sulphate and 80 parts water with resulting pain and febrile reaction. In Shaw's patient an ethereal soap solution and the cautery were used. Schleier tried cauterization with 20 per cent silver nitrate but reports almost entire destruction of the cyst wall by recurrent collection of pus over a period of two years. Irrigation of normal salt solution, Dakin's Solution, Borio-Salicylic (Thiersch's) solution, etc., have been used. Such treatment is dangerous in the presence of bronchial fistula.

The method of approach was not stated in eleven instances. Rib resection was employed thirty-seven times and partial resection of the sternum with ribs three (Koerte, Beigmann, Davies). Sometimes a flap was made of the soft tissues of the chest wall and beneath this a portion of several ribs removed. For example, Caldbick reflected a flap of the left breast and pectoral muscles and then resected a portion of two ribs. Secondary operation was often done through the previously made opening in the chest. A simple incision over the tumor was used in eleven cases. In these the growths were anterior to the sternum or in the neck where a goitre incision was mentioned twice. An opening was trephined or chiselled through the sternum five times (Kuckman, Koenig, Pflanz, Senn, Doenitz). Kavanagh reports resection of the right half of the sternum. Bastianelli resected the manubrium while Morestin folded it to the right and bisected the tumor. Moons made a flap of the right breast with the third, fourth, fifth, and sixth ribs. The author's approach is original and might be applied to other surgical intrathoracic lesions.

Complete extirpation at one sitting was reported in seventeen cases. In nine of these, the tumor was in front of the sternum or protruding in the neck and required but simple excision. All were cured. There are only eight reported intrathoracic dermoids totally removed at one stage (Caldbick, Turk, Whitemore, Naegeli, Kleinschmidt, Smith and Stone, Duval and Clerc, and the author's case). Rib resection was employed in all except in the last instance. Seven were cured. Smith and Stone's patient died five months later of sepsis.

The only death at operation was from suffocation (Spath). Between twenty-eight hours and three weeks' post-operative there were thirteen deaths, three due to pneumonia (Mandelbaum, Von Torok, Kahn), three to hæmorrhage (Koerte, Dangschat, Rautenberg), one to dyspnoea (Doenitz), one to fibrinous staphylococcic pericarditis (Goebel and Ossig), one to rupture of the cyst into the pericardium (Perves and Oudard), and four to unknown causes (Shostak, Nandrot, Masson, Sieber). From two and one-half months to five years after operation seven deaths were reported due to pyæmia (Godlee), sepsis (Smith and Stone), hæmorrhage (Black and Black), rapid growth of the tumor (Griffin), Hodgkin's Disease (McArthur and Hollister), and unknown causes (Madelung, Christian). Pohl neither mentioned the time nor cause of exitus.

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CASE REPORT—Mrs E C J consulted us March 9, 1927, complaining of Constant hacking cough, soreness in the chest, sense of fulness in the left thorax, intermittent attacks of temperature, with pain in the chest

Her family history was irrelevant Her general health had been good up until six years ago when she had a severe attack of "Flu" Ever since then she has not felt well and has lost her usual energy

Three years ago she had an attack of pleurisy accompanied by rather severe pain and soreness in the chest She has become conscious of a sense of fulness in the left thorax The hacking cough of which she complains began at this time An X-ray disclosed a tumor in the left chest apparently arising from the mediastinum After thorough study Doctor Groover made a diagnosis of mediastinal dermoid and advised repeated X-ray studies to watch the progress of the tumor

During the past three years there have been many attacks of fever with increased cough and chest soreness The expectoration has been slight in the interims, but increases during fever She has never spit up any blood except on one occasion after a severe coughing spell The attacks have gradually grown more frequent, the coughing more annoying and lately there has been dyspnoea on exertion X-ray examination made frequently during the past three years shows a gradual enlargement of the tumor In July, 1926, a bilobular development in the tumor could be made out X-ray taken September, 1926, showed the tumor nearly reaching the lateral chest wall and occupying about one third of the left hemi-thorax

On examination she was a healthy appearing woman of forty three years of age, of good color and weighing 121 pounds There was a constant, hacking, non-productive cough The general examination was essentially negative

The left chest appeared fuller in front than the right, though there was no definite bulge Respiratory expansion was good and equal on both sides The cardiac dullness extended to the nipple line There was relative dullness extending from the cardiac dullness to the first interspace There was no dullness made out over the posterior surface of either lung Auscultation revealed suppressed breath sounds over the dull area in front and in the left axilla towards its apex Examination of the sputum showed no tubercle bacilli, there were numerous chains of streptococci, many fusiform bacilli No spirocheta were seen

X-ray studies made after the oral injection of lipiodol, showed the mass lying in the front of the left hemi-thorax against the anterior chest wall A narrowing of the left bronchus with some angulation could be made out The lipiodol was seen collected in large droplets below this constriction of the bronchus

April 15, 1927, the mass was aspirated with a two and one-half c c hypodermic syringe and one c c of dirty fluid containing white flakes was withdrawn The fluid contained fatty acids, but no crystals and no cellular elements The patient believed that the aspiration had relieved the cough and had permitted her to sleep It was, therefore, decided to try to collapse the cyst by aspiration Under fluoroscopic guidance a large trocar was thrust into the centre of the tumor On releasing the trocar it oscillated widely showing the intimate connection between the tumor and the pericardium A Potain aspirator withdrew only one half c c of blood-tinged fluid This specimen revealed epithelial cells and confirmed the diagnosis of dermoid cyst

Operation was advised and agreed to It was planned to expose the cyst and remove it if possible If this was impracticable, an attempt to marsupialize it was to be made and failing this to resect the thoracic cage overlying the tumor, and thus decompress the affected lung After carefully considering all the methods of approach devised for intrathoracic surgery, it was decided to try a new incision that promised excellent exposure with minimum post-operative disturbance

The essential idea is that of a trap-door It differs from those previously used, in that the flap is larger, giving a more adequate exposure The second to the sixth ribs and half of the sternum are included in the flap The base of the flap is toward the

side and roughly corresponds to the anterior axillary line. The elasticity of the ribs allows this flap to be raised and sprung laterally without costal fracture. This gives excellent exposure to the entire hemi-thorax.

The edge of the flap is formed by the bevelled incision of the sternum. Thus when the intrathoracic work is completed the trap-door can be closed, leaving the thoracic cage intact.

The operation was performed June 14, 1927. Under ethylene anaesthesia a vertical incision was made over the middle of the sternum. The manubrium sterni was trephined with a Doyen burr, as was the lower portion of the gladiolus sterni opposite the sixth interspace. The mediastinal contents were dissected away from the back of the sternum and a Gigli guide passed from one trephine hole to the other. The saw was passed and the sternum was split longitudinally beveling the saw-cut sharply to the right. The two trephine openings were then connected to the first and sixth left interspaces with a DeVilbiss bone cutting forceps. The anterior mammary vessels were found, ligated and divided. The skin and intercostal muscles of the first and sixth interspaces were cut midway between the ribs. On elevating the flap the reflection of the pleura from the mediastinum to the anterior chest wall was exposed and divided. The trap-door could then be sprung open exposing the entire left hemi-thoracic cavity. The tumor could be seen presciting behind the pleura. The upper lobe of the lung was adherent to the upper portion of the cyst. The pleura was stripped readily from the tumor. There was one band of adhesions from the outer aspect of the mass to the lateral chest wall. The cyst was dissected with the finger and shelled out readily, except for a firm adhesion to the pericardium which was divided with scissors. On attempting to strip the upper, outer portion of the tumor from the lung and chest wall, a portion of the cyst was opened and some cheesy material and hair escaped. The pedicle arose from the anterior mediastinal tissues where the vessels of supply to the tumor were clamped and divided. The entire dermoid was taken out of the chest with very little loss of blood. The debris was sponged out of the pleural cavity and the lung expanded by increasing the oxygen pressure to 20 milligrams of mercury. The trap-door was closed and held in place by two kangaroo sutures passed around the sternum, through the second and fifth interspaces. A number two chromic suture was passed around the sixth and seventh ribs close to the sternum and another around the second and through a drill hole in the first rib. This effectually held the bevelled incision of the sternum closed. The superficial fascia was closed with a continuous locked suture of number one plain catgut. The skin was sutured with silkworm gut. No drain was used. Dressings were applied and the left chest strapped with adhesive plaster.

Her immediate post-operative condition was very satisfactory. On the third day post-operative there was some cough, her temperature rose to 100, the pulse was 130 and respirations 30. Examination under the fluoroscope showed the left chest opaque with the heart somewhat displaced to the right. In the upright position the opacity cleared somewhat toward the apex demonstrating fluid. The left chest was therefore aspirated with a Potain apparatus and about 1200 cc of blood-tinged fluid withdrawn with a great deal of air. Culture of the fluid proved it sterile. Her convalescence proceeded satisfactorily. Eleven days after operation the chest was again aspirated and 450 cc of blood-tinged fluid was withdrawn, as well as a large amount of air. She was allowed to go home in an ambulance on the twelfth day.

X-ray studies five weeks post-operative revealed a complete pneumothorax of the left side with areas of adhesions extending from the collapsed lung to the periphery. There was a slight amount of fluid. The heart was not displaced.

Calisthenics were prescribed to overcome the tendency to scoliosis and she was directed to exercise her lung by blowing fluid from one bottle to another. Rontgenograms demonstrated the gradual expansion of the lung up to January 10, 1928, when the lung was found completely expanded. Another plate made April, 1928, shows an increase of expansion and a descent of the diaphragm with clearing of the lung shadow. She is

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perfectly well, there is no cough, no pain in the chest and there has been no recurrence of the febrile attacks

Pathological report of the tumor is as follows

A grossly lobulated mass generally spherical in form and about 12 cm in diameter. Some of the lobules contain yellowish fluid, firm cartilaginous substances, others sebaceous material. In some spaces within the lobules there is a definite lining with hairy membrane and beneath the lining membrane, typical fatty tissue. At several points small masses having almost a bony consistency are seen.

Microscopic section shows typical fatty tissues with a covering of stratified epithelium in which are found hair follicles and secreting gland acini. One section is especially rich in gland acini which except for their number are characteristic of the usual skin glands. Diagnosis dermoid cyst (Multiple teratoma)

SUMMARY

In a review of the literature 137 cases of thoracic dermoids have been collected and one reported. Of these, seven were located in the chest wall anterior to the sternum and the balance intrathoracic. A few of the mediastinal growths bulged into the neck. Sixteen reports consisted of only autopsy findings. These neoplasms are probably due to fetal inclusions. The greater number was found between the ages of twenty to thirty years. The onset of the disease was most frequently insidious and the course chronic.

In a number of instances the growth gave no symptoms and was only found accidentally at autopsy. The only characteristic symptom is coughing up hairs. The other common symptoms were dyspnoea, cough and pain. The principle signs were bulging or diminished expansion of the affected hemithorax, decreased or absent tactile fremitus, dullness and distant and absent breath sounds over the tumor. The heart and liver in some cases were displaced. X-ray showed a definitely outlined, non-pulsating mass. Examination of the sputum and material aspirated from the growth were important diagnostic aids. The pathology of the neoplasms varies from the simple dermoid containing dermal structures to the complicated teratoma which consists of derivatives of all three germ layers.

The principle complications were perforation of the cyst, pneumonia, pleural effusion and malignant degeneration. The diagnosis is made by the entire picture of the disease. The prognosis is grave unless the neoplasm is removed or its development curtailed. Palliative measures include aspiration, incision and drainage, and decompression.

Complete extirpation is the only cure. There were seventy-three cases operated, forty-five in one sitting and the balance principally in two- to four-stage procedures. There were twenty-eight cured, twenty relieved, twenty-two deaths, one unchanged and in two the result was not stated. Complete extirpation at one sitting of an intrathoracic dermoid has been reported only eight times with one death.

The method of approach was rib resection except in the author's case. In this instance under ethylene anaesthesia the sternum was split longitudinally with a bevelled edge and by dividing the intercostal muscles in the first and sixth interspaces a trap-door was sprung open with its base at the anterior

axillary line without costal fracture This exposed the entire left hemithorax The tumor was shelled out and the flap closed without drainage meanwhile expanding the lung This method of thoracotomy is probably applicable to other intrathoracic lesions

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RELATION OF ATELECTASIS TO OPERATIVE PNEUMONIA

DR WALTER E LEE, Philadelphia, read a paper with the above title, for which see ANNALS OF SURGERY, July, 1928, Vol LXXXVIII, I 6

DISCUSSION DR CHARLES L GIBSON, New York City, reported nine cases of massive collapse of the lung recently. The last two were subjected to a treatment which is a definite contribution to the etiology and the effective treatment of this condition. This is along the lines that Docor Lee has described, and he was inclined to think that it is going to call for much less use of the bronchoscope. The first case was a young man of twenty-one, who exhibited cough, temperature and increased respirations on the night following operation. Diagnosis was confirmed by X-ray on second post-operative day. The examination of the thorax showed marked opacity of the entire chest and quite marked deviation of the trachea, heart and mediastinum to the left side. The findings indicated a massive collapse.

The house surgeon placed the patient on the sound side, then slapped him smartly on the affected side, whereupon the patient immediately became very uncomfortable, gagged, struggled, got blue, looked as if he might choke to death, and finally got rid of a huge gob of mucus and was clinically

relieved at once. The X-ray pictures taken thirty minutes afterward showed already the beginning of reërection of the chest and the restoration to their normal positions of the cardiac shadow and the trachea.

The second case was a man whose symptoms developed at the end of the first twenty-four hours, and he was given the same treatment, after the X-ray had shown a massive collapse.

DR KARL KORNBLUM, Philadelphia, Penna., said that his interest in post-operative atelectasis was from the standpoint of the roentgenologist. They had had occasion at the University Hospital in Philadelphia to examine a great many cases of so-called post-operative pneumonia, but until recent



FIG 1—Bilateral Lobular Atelectasis

years they had not really understood the underlying pathology in these patients. The X-ray appearance in massive atelectasis is quite distinctive and easily recognized. In examining numerous such cases they had only found massive atelectasis and lobar atelectasis occurring in relatively few patients. Since the recognition of this condition they had more or less routinely examined all post-operative cases that had shown evidence of pulmonary complications and had frequently detected a lesion at one or both bases which roentgenologically has the appearance of a bronchopneumonia. Recognizing, however, that

these patients did not run a course typical of bronchopneumonia, they had attempted to conceal their ignorance by reporting such lesions as a pneumonitis. Through the work of Doctor Lee they now recognize these cases as lobular atelectasis. The Rontgen-ray features of lobular atelectasis are prominence of the trunk shadows and diffuse mottling throughout the involved area (Figs 1 and 2). These areas are usually in the base of the lung and quite often bilateral. Likewise there may be some elevation of the domes of the diaphragm, and fluoroscopically one at times sees a restriction of motion of the diaphragm, and this motion is very apt to be jerky in character.

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There is not often, however, a displacement of the heart which is characteristic of massive atelectasis

Of necessity, post-operative cases must be examined in bed, and bedside films are never as satisfactory, as far as interpretation is concerned, as films made in the erect posture. The reason for this is that in bed, when the films are made, there is not complete aeration of the lungs, and likewise the dome of the diaphragm is always higher in films made in this manner. It is very easy therefore to miss small patches of lobular atelectasis which are concealed by the dome of the diaphragm. In order to avoid such an error they routinely examine patients in the lateral position, as this is the best view for showing the posterior portions of each base.

Lobular atelectasis roentgenologically has practically the same appearance as bronchopneumonia, and they are not as yet able to differentiate these conditions but must depend largely upon the history of the case. The diagnosis is usually confirmed by the subsequent course of the condition inasmuch as these patients recover in a few days to a week. This recovery can be followed very nicely by subsequent X-ray examinations. Most of their post-operative patients have shown lobular atelectasis. This fact has led them to believe that the condition



FIG 2—Same Patient as in Fig 1, Lateral View

is far more common than is generally appreciated. With a view to establishing its frequency, they have recently asked permission of the Surgical Department of the University Hospital to examine routinely all post-operative cases in which an X-ray examination is not distinctly contraindicated.

In this connection he made a statement which is not generally appreciated by clinicians, and that is the fact that a bedside X-ray examination is less harmful and less detrimental to a patient and less disturbing than a properly conducted physical examination of the chest, so that there need be no fear of subjecting the recently operated patient to an X-ray examination.

Dr W J M Scott, Rochester, N Y, remarked that most recent investi-

gators of massive atelectasis agree that there must be obstruction to the respiratory tree at some point. He differed from Doctor Lee in only one point, namely, that he believed that the obstruction arises originally in the bronchioles, or the finer respiratory passages ordinarily rather than in the main bronchus. Consequently he thought that bronchoscopic aspiration is unnecessarily severe.

Surgeons have now gone on to the stage of attempting to prevent massive atelectasis in these cases, and with some success. All of their patients having a general anaesthetic, all of their operative cases, are hyperventilated by carbon-dioxide at the end of the operation. In a series of 2,000 major operative cases under the previous regime, our incidence in Doctor Cutler's clinic was 6 per cent. of post-operative massive atelectasis, that is, the unilateral variety about which there is no question at all in the diagnosis. After the institution of hyperventilation at the end of operation by means of carbon-dioxide inhalation, the incidence has been reduced from 6 per cent. to 2 per cent. While he did not believe that this will entirely prevent all instances of massive atelectasis, it will definitely diminish their incidence.

TRAUMATIC EMPHYSEMA

By JOHN DOUGLAS, M D

AND

PAUL C MORTON, M D (By INVITATION)

OF NEW YORK, N Y

THE subject of traumatic or surgical emphysema is rather casually touched on in most text-books on surgery. Articles in the literature within the last few years have largely been of isolated or small groups of case



FIG 1—Extensive emphysema of upper part of body following mediastinal escape of air

reports, which have as their etiological factor some other cause rather than ordinary accidents resulting in injuries to the lung. The opportunity of seeing a group of cases over a short period of time having different types of chest injuries with varying pathological results, stimulated our interest in this subject and the treatment in two of these cases, varying from that recommended in most text-books, seemed to make it worth while to briefly review this subject.

The term subcutaneous emphysema has been avoided, as while part of the symptomatology is due to a subcutaneous collection of air in the tissues, in the cases observed, the radiograph showed that a large amount of the air was interstitial or beneath the fascial planes as well as in the subcutaneous tissue, and the spread through the tissues seemed to be modified according to which layers of fascial planes limited the extension of the emphysema. The emphysematous condition of the tissues is only part of the pathological lesion, and in the series of cases observed, it occurred with or without a pneumothorax, and with or without a penetrating wound of the chest.

It was due to a lesion of the cortical surface of the lung, caused in one instance by a stab wound of the chest penetrating the lung and in another by a fractured rib with no external injury. In another patient it resulted from a crushing accident where quite obviously air had escaped from some deep injury to the air vesicles in the region of the hilus, traveling up the mediastinal tissues into the neck and from there spreading throughout the tissue planes between the muscles and under the skin, over the whole body. In contrast to this latter case, a child who received a similar crushing injury from an automobile accident had a pneumothorax with absolutely no evidence of emphysema.

Beside those cases of traumatic emphysema caused by crushing or penetrating injuries of the chest which damage the lung, many other factors are



FIG 2—Lower part of body of same patient

listed in the etiology of this condition. Cases are reported as occurring during labor, following tonsillectomy, occurring as a result of fracture of the nasal bones, perforating duodenal and gastric ulcers and injuries to the retro-peritoneal surface of the duodenum or colon, and as a result of injury to the lung while performing an artificial pneumothorax, or aspiration, and in the administration of anaesthesia by the direct insufflation method. A series of cases secondary to pneumonia which occurred during the influenza epidemic of 1918, have also been reported. It is rather interesting to observe that, in certain lacerated wounds of the extremities, air may be sucked into the tissues, probably by the sliding action of the tissue planes, and air has been introduced into the tissues while giving a hyperdermodysis, which might cause the presence of a gas bacillus infection to be suspected. Only those cases due to chest injuries will be considered in this article.

Pathology—The mechanism of the entrance and diffusion of the air into the tissues apparently is due to the escape of this air from an injury

TRAUMATIC EMPHYSEMA

of one or more of the air vesicles, either on the surface of the lung or in the neighborhood of the hilus. This is most frequently seen where a fractured rib has lacerated the lung cortex and overlying, as well as the parietal, pleura. In such a case it can be easily understood how this air may be gradually pumped into the tissue planes covering the chest wall and thus spread a varying distance throughout the body. Several of the text-



FIG. 3.—Radiograph of upper part of body same patient. Note pneumothorax.

books on surgery repeat the old statement, as to etiology, made many years ago by McEwen who found in one case, that a roughened fragment from a fractured rib had pierced the surface of the lung which remained hooked over this sharp fragment, and allowed the air to escape into the tissues. This, however, is probably a rare condition. In one case which is reported herewith, the radiograph shows the air extending upward through the mediastinum into the tissues of the neck. The patient, a small boy, when seen by the ambulance surgeon a few minutes after his accident already had a marked

DOUGLAS AND MORTON

emphysema over the face and neck and upper part of the trunk, the eye-lids being so emphysematous that they were closed (Figs 1 and 2) Subsequent X-ray showed a collapsed lung with a pneumothorax, but the existence

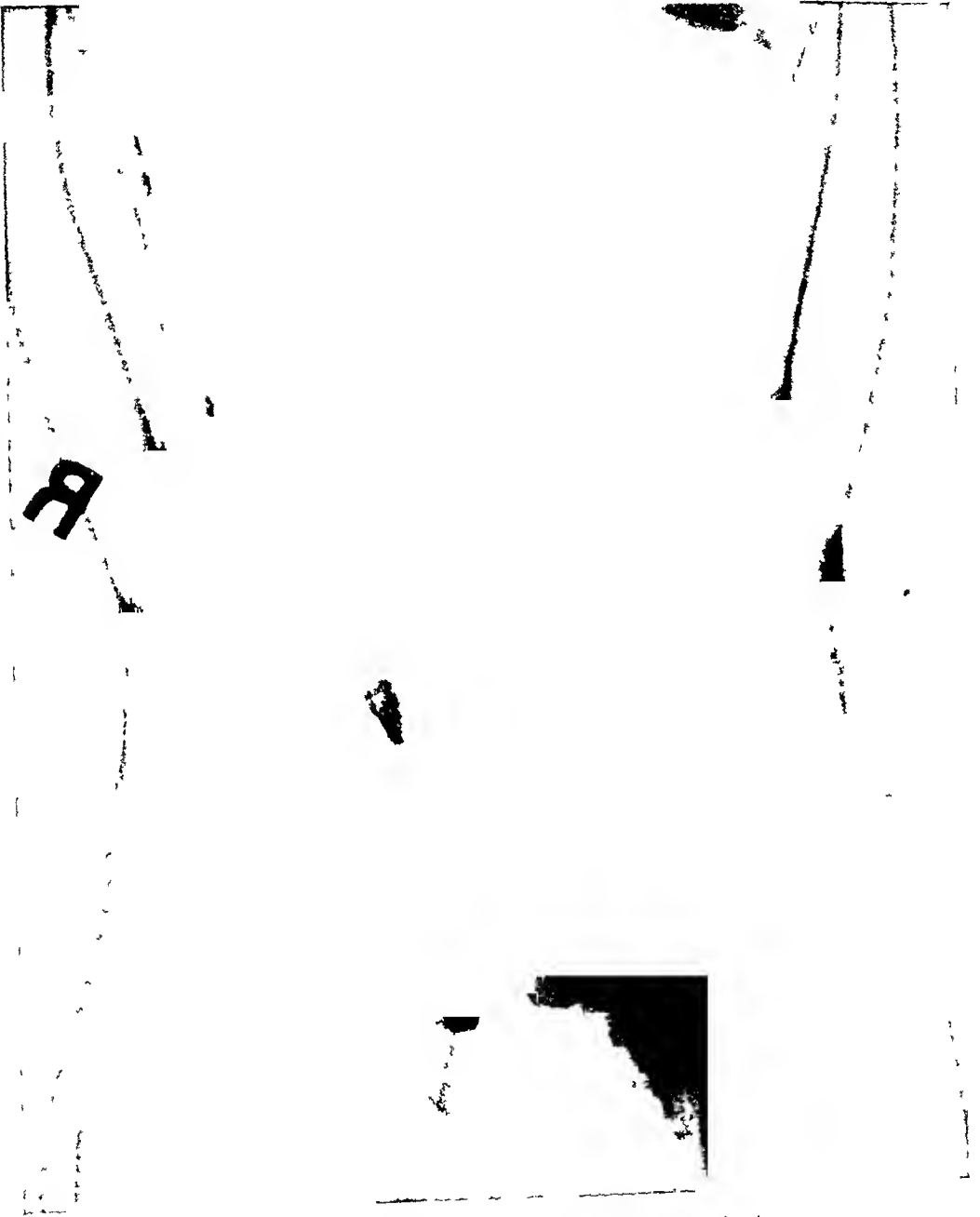


FIG 4—Radiograph of lower part of body same patient

of the collapsed lung did not prevent the extension of the emphysema (Figs 3 and 4)

In one case of traumatic emphysema, due to a stab wound of the chest wall penetrating the lung, the emphysema spread more slowly but there was no pneumothorax and the surface of the lung when cut down on seemed to be in contact with the parietal pleura In a contrasting case of injury to

TRAUMATIC EMPHYSEMA

the chest, accompanied by a cerebral concussion and multiple contusions, the radiograph showed a pneumothorax but no evidence of emphysema. In another case of emphysema due to a fractured rib, the most common cause of surgical emphysema, it would appear that some injury of the lung surface and both layers of the pleura must have occurred, there being no external injury.

There seem to be two types of injury resulting in traumatic emphysema, which the above cases typify. First, those in which there is an injury to the chest wall, either from a fractured rib or a penetrating wound which results in an escape of air into the tissues of the chest wall at the site of injury. Second, those cases in which the chest injury results in a rupture of some of the air vesicles in the neighborhood of the hilus of the lung, and through which the air escapes into the mediastinum and spreads upward into the neck and then through the body. The mechanism of the escape of air from the vesicles of the lung through the mediastinum and thus into the tissues through the extra-pleural route, has been well demonstrated by Berkeley and Coffin.¹ During the 1918 epidemic of influenza they



FIG. 5.—Photograph of patient four months later. Note four scars of incisions.

had under their care in an army camp, 1,701 cases of broncho-pneumonia. Of these, nine cases developed a generalized interstitial emphysema and spontaneous pneumothorax. There were two other cases, following operation for empyema, developing a similar condition after operation in which the development seemed to be unrelated to the operation. The emphysema was always first observed at the episternal notch or above the clavicle. By means of X-ray studies and autopsy they were able to show ruptured air sacs in the

neighborhood of the hilus of the lung, followed by "air streaks" developing along the blood-vessels to the posterior mediastinum, then extending to the superior mediastinum and along the larger blood-vessels under the fascial planes to the neck and axilla. A valve-like action where the bronchiole entered the air sac, kept up a constant supply of air to be pumped into the tissues. In such cases the air distends the mediastinal tissues, making pressure on the large veins of the thorax.

The extension of the emphysema depends on both the amount of escaping air and its limitation by the fascial planes. In some cases the spread stops along the lower margin of the jaw and does not extend into the face, although distending the tissues of the neck. It may stop at Poupart's Ligament in the groin and not enter the thighs although the scrotum may be markedly distended. In severe cases where it follows the deep fascial planes, it extends from the scalp to the soles of the feet and lies not only subcutaneously but surrounds the various muscles as is very well shown in Figures 3 and 4.

Symptoms—The symptoms of the emphysema itself are characterized by the crackling due to the air in the tissues which is only part of the clinical picture, the general symptomatology of the patient depending on the amount of lung injury, pneumothorax, possible infection and other traumatism accompanying the original accident. The presence of a pneumothorax is sometimes difficult to determine without a radiograph, as the air in the chest wall may muffle the respiratory sounds and even in the absence of a pneumothorax give an exaggerated tympanic note on percussion. That this is caused by the air in the subcutaneous tissues may be proved by percussing over an area such as in the lumbar region which is normally dull but which, in the presence of marked emphysema of the tissues, will give quite a tympanic note. Over the areas of emphysema there is pain and tenderness on pressure. Perhaps the emphysema alone is not the cause of death nor does it add greatly to the severity of the symptoms.

Sauerbruch,² however, as early as 1908, reported a case in which after a crushing injury of the chest, resulting in a severe general emphysema, the air escaped by way of the mediastinum. He observed that the distention of this region caused much pressure on the veins of the chest with marked congestion, especially of the inferior vena cava. He operated on this case in his negative pressure chamber and noted that after the "cutaneous" incision the emphysema of the tissues disappeared within a few minutes. He then opened the chest and observed the general improvement which occurred in the patient on the escape of air from the mediastinum. He states, however, that the patient died later. Tiegel³ successfully treated a case of mediastinal emphysema by making a 4 centimetre incision in the episternal notch down to the trachea and applied continuous suction by means of a glass bell placed over the wound with 30 millimetres of negative water suction for five days. It is, therefore, reasonable to suppose that in a patient suffering from an injury to the lung, with or without other body injuries, the pain and embarrassment to circulation and respiration caused by the marked distention of

the body tissues with air may have considerable influence on the recovery or process of convalescence. This embarrassment would be more severe if there were a marked emphysematous condition in the mediastinum.

Treatment—In most text-books on surgery, it is stated that the emphysema requires no treatment as it is self-limited, and while puncture of the subcutaneous tissues is suggested in the very severe cases, it is usually advised against because of the danger of infection. It is true that in most cases the air will be absorbed, but in the case of a patient whose symptoms appear to be getting worse and the emphysema spreading, it has seemed to us justifiable and wise to limit this spread if it can be done without injuring the patient. This is our excuse for presenting this article.

The case reported, a boy in whom the air escaped along the mediastinum from a deep lung injury and in whom the eyes were closed and the face, neck and trunk markedly distended within a few minutes after his injury, was watched for forty-eight hours before anything was done. At the end of forty-eight hours he appeared to be getting worse. It was then decided to relieve this distention by incision into the tissues. Two cuts were made parallel with the ribs on each side of the chest, with the escape of a very considerable amount of air and an immediate improvement in his symptoms. While it might be that this boy would have recovered without this therapeutic measure, he had continued to get worse until it was done, and his marked improvement was so coincident with the relief of the emphysema that it is believed it was a life-saving measure in his case.

In a second case, a woman had received a stab wound in the fifth intercostal space just internal to the posterior margin of the scapula. There was an increasing emphysema of the chest wall which had spread along the abdominal wall on that side as far as Poupart's ligament. While this woman's condition did not appear to be dangerous, in view of our experience with previous cases, it seemed wise to attempt to limit the spread of this emphysema. This was accomplished by cutting down, under local anæsthesia, along the line of the stab wound as far as the pleura, the wound being packed with iodoform gauze through the existing opening of the pleura, thus making impossible further escape of air into the tissues. There was no further spread of the emphysema. At the end of a week there was still an accumulation of air in the tissues as far down as the left inguinal region. This area was tender on pressure and caused pain on movement in bed. For the purpose of relieving this pain and tenderness, a small incision was made, under local anæsthesia, over this area and the air was found not in the subcutaneous tissues, but lying under the deep fascial planes. The air escaped through the incision, the wound was lightly packed and the pain and tenderness almost immediately disappeared, the wound healing rapidly.

Aspiration of the chest or introduction of a suction apparatus has been advocated in severe cases of emphysema, accompanied by pneumothorax. It would appear to us that during the time that the emphysema is spreading, this would not be good treatment. If the aspiration or suction were sufficient to expand the lung it would keep open the wound or opening in the lung through which the air escaped, and in those cases where severe lung injury were present, accompanied by hemorrhage, would promote the continuance of the hemorrhage. This opinion would appear to be borne out by two of the cases reported by Berkeley and Coffen in which the emphysema appeared at the episternal notch and above the clavicles after operation for empyema. It is a fair assumption in these cases that the relief of pressure

on the lung allowed the escape of the air into the mediastinum, and that a similar result would follow aspiration or suction treatment of the pneumothorax where this was accompanied by an interstitial emphysema traveling along the extra-pleural route from the hilus of the lung

It is not intended that these two forms of treatment be applied to all cases of traumatic emphysema. However, it is our belief that relief of symptoms, prevention of the spread of the emphysema and perhaps saving of life may result from employing these methods in certain cases, rather than following the advice of doing nothing as appears in most text-books, where the danger of infection following small incisions under local anæsthesia is warned against, as it might have been in preantiseptic days from which this lack of treatment has probably been handed down

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DR EMMET RIXFORD, San Francisco, Cal., said that inasmuch as Doctor Douglas had mentioned several forms of acute subcutaneous emphysema independent of wounds of the lung, he might mention two in which air was left in the abdomen, probably as a result of elevating the edges of the wound in order to lessen the trauma of reintroducing the intestines. A considerable amount of air was left in the abdomen, and this after a few days gradually percolated out between the stitches, and not an extensive but a very definite subcutaneous emphysema occurred in the abdominal wall, so much so as to make them fear infection by the Welch bacillus or with some of the intestinal anaerobes, but the matter cleared up in both cases very promptly

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(Continued)

END RESULTS IN HODGKIN'S DISEASE AND LYMPHOSARCOMA TREATED BY THE MIXED TOXINS OF ERYSIPELAS AND BACILLUS PRODIGIOSUS, ALONE OR COMBINED WITH RADIATION

By WILLIAM B COLEY, M D

OF NEW YORK

IN 1915, in a paper on *Primary Neoplasms of the Lymphatic Glands including Hodgkin's Disease*,¹ I reported the end results in 167 cases treated almost entirely with toxins alone. Up to that time radiation had been used with but little success in these cases. While this method (radiation) has since become the generally accepted one in the treatment of lymphosarcoma and Hodgkin's disease, only very recently have the end results in a large series of cases been published. Among the most noteworthy of these publications are the report of Minot and Isaacs,² as well as that of Burnam³ and of Stone.⁴ From these data I believe it is now possible to get a fairly accurate estimate of the value of radiation in the treatment of lymphosarcoma and Hodgkin's disease.

It has been found that while radiation has resulted in a marked diminution in size—and in some cases, a complete disappearance—of the enlarged glands, in most cases the disease recurs after a longer or a shorter interval and proves fatal in practically every case. Just how much radiation adds to the duration of life of an individual suffering from lymphosarcoma or Hodgkin's disease is still problematical, at least, in the opinion of Minot and Isaacs. That this method of treatment has resulted in great temporary relief, there can be no doubt.

At the onset it is important to make clear what we mean by the term

¹ Coley. Trans. of American Surgical Association, 1915.

² Minot and Isaacs. Jour. Amer. Med. Ass'n, April 17 and 24, 1926, vol. LXXXV, Nos. 16 and 17.

³ Burnam. Jour. Amer. Med. Ass'n, October 30, 1926, vol. LXXXVI, No. 18.

⁴ Stone. Canadian Practitioner, March, 1924.

"lymphosarcoma" or "Hodgkin's disease" For many years I have held that these two conditions, which are usually regarded as quite different and distinct, are actually quite closely allied etiologically, and bear such a close resemblance to one another that in some instances it is impossible to differentiate them either clinically or histologically While on the one hand we may have a typical lymphosarcoma with definite clinical and histological features, and on the other, a typical Hodgkin's disease with discrete, freely movable glands, firmer in consistence than lymphosarcoma but not as hard as tuberculous or carcinomatous glands, and histologically containing the typical Dorothy Reed cells, we also have a great number of cases that are more or less atypical and fall between the clear-cut typical lymphosarcoma and the typical Hodgkin's disease While it may be possible to regard these slightly different atypical conditions as distinct processes with definite etiology, I believe it is far more logical and more rational to regard them as varieties of a single disease On this assumption we are justified in including them all in a general group, which is just what Minot and Isaacs have done, and to which group they have given the name *lymphoblastoma*

In their publication referred to, Minot and Isaacs state as follows

"The views and opinions concerning the nature and relationships of such cases are multiple, and thus students of the problem have utilized a constantly confusing terminology, and not infrequently disagree on the exact diagnosis of a given case Some apply a term that is synonymous with one used by another, while at other times a special type of case is designated by a name used by others to cover a much broader group Hodgkin's disease with the pathologic histology described by Dorothy Reed is sharply distinguished by many authorities from two other conditions that they term pseudoleukemia and lymphosarcoma Others inappropriately include as Hodgkin's disease all, more often some, cases of the latter two conditions, and the terms malignant lymphoma and lymphadenoma have been used for such a group alone Some contend that two types of lymphoblastoma may occur in one patient Confusion in the group called lymphosarcoma arises because of differences of opinion as to what constitutes this condition and the lack of appreciation of the difference between the origin of tumors involving structures composed of much lymphatic tissue Pseudoleukemia and aleukemic lymphocytic or lymphoblastic or lymphatic leukemia are essentially synonymous, as is at times the term aleukemic lymphadenosis Chronic lymphatic leukemia with a leukemic blood picture is the form of lymphoblastoma most easily separated from others However, except for the peripheral blood picture, no important distinction, even by pathological examination of tissue, can be made from cases termed pseudoleukemia or aleukemia, and the same case at different times may be given correctly the one name or the other"

While the systemic nature of Hodgkin's disease had been recognized by many writers, and this point fully established by Gowers⁵ in his exhaustive paper published in 1879 in which he described the lesions as involving not only the lymph-nodes and spleen, but also the skin, intermuscular tissues, bones brain, soft palate, pharynx, tonsils, esophagus, stomach, small intestine, large intestine, pancreas, peritoneum, thyroid, thymus, trachea, lungs pleura, diaphragm pericardium, heart muscle, suprarenals, kidneys, testes and ovaries, only recently has our attention been called to the fact that the disease involves not only the nervous system, but, as Ginsburg⁶ has pointed out, the

Gowers System of Medicine, Philadelphia, 1879, vol v, p 306

⁶ Ginsburg Archives of Internal Medicine, April, 1927, vol XXXV, pp 57-595

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skeletal bones as well. According to the latter, "the impression is still widely prevalent among physicians that the nervous system is so rarely involved in Hodgkin's disease as to be ignored in the differential diagnosis of diseases of the nervous system. Not only did I fail to see Hodgkin's disease mentioned in the standard textbooks on diseases of the nervous system, but even in the excellent recent monograph of Elsberg on *Tumors of the Spinal Cord*,⁷ the condition is ignored completely." Ginsburg states that in a series of thirty-six patients with Hodgkin's disease observed at the Montefiore Hospital during the years 1914 to 1925, ten patients, or 27.7 per cent, showed invasion of the nervous system.

In the opinion of Ginsburg, the etiology of Hodgkin's disease still remains obscure, and a specific form of treatment has not been discovered.

In a paper on *The Relation of Hodgkin's Disease to Lymphosarcoma*, Gibbons of San Francisco,⁸ discusses the nature of the process as follows:

"Two possibilities as to the nature of the process are apparent, *viz.*, is it a malignant, or is it an infectious process of the character of a granuloma? Most recent writers are inclined to the latter view. Reed is most insistent. Fischer, Clark,⁹ and Simmons also hold this view. Longcope seconds it, though guardedly. Recent German publications also favor this view. Yamasaki,¹⁰ regards the condition as a granuloma not of tuberculous but of unknown origin, which, however, may end in sarcoma. Wamecke,¹¹ although he has clearly recognized that lymphosarcoma cannot be separated from Hodgkin's disease, still adheres to this conception. From the study of my cases I incline strongly to the malignant theory."

Gibbons adds:

"It will be seen at once that many of these facts belong to malignant tumors as well as to infectious processes. We may have a rapidly growing sarcoma or we may have a slow one. We may have it accompanied by fever or we may not, and the fact that the fever of Hodgkin's disease is so variable in character, and sometimes not present at all, rather argues that it is not one produced by a definite infection. We see sarcomas which have existed for a long time, suddenly assume a very much accelerated growth. The mode of spread from diseased glands to adjacent ones is equally characteristic of malignant growths and of infectious diseases. The final stage of anaemia, cachexia, and disturbances of the body functions is very characteristic of the last stages of all malignant growths."

Regarding the nine cases which formed the basis of Gibbons' report, he states:

"Three of the cases were undoubtedly malignant, infiltrating and destroying surrounding structures as does any malignant growth. The only question that remains is, can these be classed with Hodgkin's disease, or are they different and to be classed as lymphosarcoma? Osler asserts that infiltration of the lung, as took place in one of my cases, does not occur in Hodgkin's disease, and that when such an infiltration does take place the disease is true lymphosarcoma. But in the light of the fact that this case, as well as the two other malignant tumors of the neck, present the same clinical features

⁷ Elsberg: *Tumors of the Spinal Cord*, Paul B. Hoeber, New York, 1924.

⁸ Gibbons: *Amer. Journ. of the Medical Sciences*, November 1906.

⁹ Clark: *British Medical Journal* 1901, vol. II, p. 701.

¹⁰ Yamasaki: *Zeitschr. f. Heilk.* 1904, p. 269.

¹¹ Wamecke: *Mitt. aus den Grenzgeb.* 1905, vol. XIV, p. 275.

and the exact histological picture as the twenty-three cases so carefully studied by Reed, Longcope, and Simmons, and as the other six of my series, they must also be regarded as the same morbid condition. This being established, there would be no question as to the malignant character of Hodgkin's disease."

In conclusion Gibbons states

"1 I agree with Reed, Longcope, and Simmons as to the histological picture presented by the tissues in Hodgkin's disease, but I do not agree that it is necessarily due to an inflammatory process

"2 I assert that in most cases infiltration of the capsule of the diseased glands can be observed, in many cases an extension beyond the capsule occurs, and in some cases very evident infiltration of adjacent structures

"3 The study leads me to believe that Hodgkin's disease is a process to be classified with malignant tumors"

One of the most important of recent contributions upon Hodgkin's disease is the Schorstein lecture of 1926 on *lymphadenoma*, (Hodgkin's lympho-granuloma), by Sir Humphrey Rolleston, (Regent Professor of Medicine, Cambridge University). It contains a brief note upon the history of the disease from its first definite description by Thomas Hodgkin and his first published series of cases in 1832, and Samuel Wilks in 1856 and 1865. A lucid discussion of the various theories on the nature and origin of Hodgkin's disease follows. Under the *Nature of Malignancy in Hodgkin's Lympho-granuloma*", the arguments for and against regarding it as a neoplasm are presented in a most clear and judicial manner.

"That Hodgkin's lympho-granuloma is malignant in the sense that it leads to death is undoubted, and it differs from tuberculosis, which in many respects it closely resembles, in being constantly fatal and not becoming obsolete. But further evidence suggesting malignant characters, such as invasion of adjacent bone and the histological characters of sarcoma, described years ago by Yamasaki and by Karsner, are now established, and Ewing considers this transformation into sarcoma ('Hodgkin's sarcoma') as a tumor *suu generis* and as by no means rare. He describes the new cells as endothelial in origin, but losing this character and appearing as large round cells, so that the term endothelioma is hardly applicable. Such a transformation as the result of long-continued irritation is, of course, well recognized, and Ewing has described it in lymphatic glands affected with chronic granulomatous infection. The occurrence of Hodgkin's sarcoma as a late result of Hodgkin's lympho-granuloma is rather remarkable, as it is very seldom recognized in the other infective granulomas.

"The development of sarcoma in Hodgkin's lympho-granuloma might be explained in one of two ways (1) that some of the constituent cells of the lympho-granuloma proliferate so vigorously as to become a sarcoma, or (2) that the tissues surrounding a mass of lympho-granuloma are excited by the chronic irritation to a proliferation which eventually becomes sarcoma. This process Ewing compared with the occurrence of cutaneous squamous-celled carcinoma in the site of lupus.

"Prof H M Turnbull, while fully recognizing the existence of the condition which Ewing terms Hodgkin's sarcoma, regards it as the 'lymphosarcomatoid' form of Hodgkin's lympho-granuloma and as inflammatory rather than neoplastic. Lymphosarcoma—the form of growth concerned in the malignant transformation of Hodgkin's disease—he considers as closely allied to it, and like it an inflammatory and not a neoplasm."

I agree with Professor Turnbull in so far as he attributes a common etiology to both Hodgkin's disease and lymphosarcoma, and I will go still

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further in regarding them both as infectious processes. But this does not in my opinion, make it necessary to exclude them from the class of neoplasms, since I believe that both sarcoma and carcinoma are likewise due to the irritation of some infectious agent.

As Rolleston well says, "Gye and Barnard's discovery of an ultra-microscopic virus and specific factor for new growths, and the existence of infective sarcomas make discussion of the *pros* and *cons* of the neoplastic nature of Hodgkin's lympho-granuloma rather an academic exercise than one of practical utility." This was written before later research work had failed to confirm the conclusions of Gye.

Rolleston's paper contains an admirable picture of the more important clinical manifestations of Hodgkin's disease.

Hodgkin's Disease of Bones—It has long been recognized that the bone marrow was involved in certain cases of Hodgkin's disease. Ziegler¹² believes this occurs in 30-40 per cent of cases, and Symmers¹³ goes so far as to believe the bone marrow is affected in every case. It is only comparatively recently that clinicians have recognized the fact that in certain cases of Hodgkin's disease very definite metastatic tumors of the bone may be found. Symmers found definite bone invasion in 50 per cent of fourteen cases, and Sir Humphrey Rolleston believes that this invasion of bone by lymphadenoma (Hodgkin's disease), is now generally recognized. He states that "among thirty-nine necropsies of the London Hospital, Professor Turnbull found the bone marrow invaded in 49 per cent, the femur most often affected." From a study of the sites affected, he believes that the femur is invaded through the blood stream and the spine by direct extension from the affected retroperitoneal glands. Sir Humphrey Rolleston raises an interesting question whether all bone marrow infection is a part of a widespread reaction to the stimulus of an unknown virus, or whether it is secondary in the same way as a generalized tuberculosis is to an infection from a primary focus. Professor Turnbull concludes it is secondary.

After a careful study of my own cases with bone invasion, I am inclined to agree with Professor Turnbull's views. Here again we find a close analogy to malignant tumors and I believe that the bone invasion and the involvement of other glands and other tissues are closely allied to the metastatic tumors seen in cancer. In nearly all cases it starts in as a primary focus and the multiple tumors result from the infection carried through the blood stream.

Bone invasion may result in paraplegia. I have observed only one case of this kind and in this case the invasion of the spine was probably due to direct extension. The disease started in the glands of the right groin and iliac fossa and was controlled nearly a year by radium and toxins, then recurred and progressed rapidly in spite of further treatment. The lumbar glands were invaded and in a few months the patient developed paraplegia and died about three months later. The diagnosis was confirmed by Doctor

¹² Ziegler. *Die Hodgkinsche Krankheit*, Jena, G. Fischer, 1911.

¹³ Symmers. *Am J M Sc*, vol. clvii, pp. 157 and 313, 1924.

Ewing from a microscopical study of the gland removed. I have had one other case with involvement of the lumbar vertebræ from Hodgkin's disease, and here also the primary focus was in the inguinal glands.

I have had two other cases of direct invasion of the skeletal bones. One of these is of sufficient interest to warrant a brief citation.

The following personally observed case illustrates this tendency of the disease to metastasize in bones, and is interesting because of the remarkable effect produced by very large doses of toxins given after rontgen-ray had failed to control the disease.

CASE I.—M. G., female, aged forty-eight years. The patient's family history was negative. In October, 1916, she had noticed enlarged glands, the size of a marble, in both sides of the neck. These had gradually increased in size and number and were accompanied by a cough. In September, 1918, a tonsillectomy was performed by Doctor Blake, of Pittsburgh, Pa. Later on, a nodule was removed from the neck, and the pathologist of the *Mercy Hospital in Baltimore, Md.*, pronounced it to be Hodgkin's disease. In February, 1921, the patient was referred to me by Dr. Lawrence Litchfield, of Pittsburgh. At this time she complained of pain, cough, inability to open mouth, and loss of weight and strength. For three years previously she had been treated with rontgen-ray. The disease had been held in almost complete control, but in the latter part of 1920, the glands of the neck became enlarged and masses appeared in both mastoids and frontal region. She was admitted to the Memorial Hospital on February 21, 1921, at which time physical examination showed a patient in fairly good general condition. There was a hard, fixed mass in the left frontal and parietal region, measuring one and one-half inches in diameter, and protruding one-half inch above the normal contour of the skull. In both mastoid regions were large, hard swellings, the size of an English walnut, firmly attached to the bone. In the right side of the neck below and posterior to the mastoid was a mass as big as an egg. Over the occiput was another swelling of the same character as the others. The jaws could be opened only about one-half inch. There was marked telangiectasis.

Increasingly large doses of the mixed toxins were given daily. After one week it was noticed that the masses in the skull were very much smaller, the patient was able to open her mouth wider, and she complained of less pain. By March 15, or after about three weeks' treatment, the pain had entirely disappeared, the masses were very much smaller, and her general condition was considerably improved. By April 26, the patient was practically symptom-free: there was no cough, no lumbar pain, her appetite was good, and the mobility of her jaws was practically normal. The patient was unable to remain in the hospital any longer, and the treatment was continued more or less irregularly and in smaller doses at home. After a few weeks she began to grow worse and in about six months she died.

The foregoing case, while not finally successful, is of the greatest interest for the reason that it is one of the few advanced cases of Hodgkin's disease with extensive bony tumor in both the mastoid and frontal bones. After a failure to control with rontgen-ray, the lesions practically all disappeared as a result of very large daily doses of toxins (25 minims a day—the largest dose I had ever given).

Whether the result would have been otherwise had I been able to keep her longer under treatment, it is impossible to say, but I believe that treatment was begun at a stage too far advanced to expect more than temporary control. If the systemic treatment with the toxins could produce such remarkable disappearance both of the tumor of the bone and soft parts in a few

weeks, it would seem sufficient evidence to justify our making use of this agent in the earlier stages of the disease when there is a greater hope of complete control

Diagnosis of Hodgkin's Disease—An entire paper might be devoted to the very difficult question of the differential diagnosis of lymphosarcoma and Hodgkin's disease from the other forms of glandular enlargement, *e g* tuberculosis of the glands, chronic or subacute lymphadenitis, or leukæmia but space will permit only a very brief outline of the more important features. The reader is again referred to the admirable paper of Sir Humphrey Rolleston for a lucid discussion of diagnosis and prognosis of Hodgkin's disease. What he has to say on the value and fallacies of biopsies is of especial interest.

According to Rolleston, "*infiltration of the skin*, by Hodgkin's lympho-granuloma, apart from extension from immediately underlying lymphadenomatous glands, is much rarer than the skin changes of prurigo. In 1924 I could collect twelve cases only. It thus contrasts with mycosis fungoides, which, indeed, has been thought by Ranvier (1869) and K. Ziegler (1911) to be the cutaneous form of Hodgkin's disease, a view difficult to harmonize with the histological appearances. The cutaneous tumors in Hodgkin's lympho-granuloma may be small or large and flat, they grow slowly and seldom, as in Langley and Cole's cases, ulcerate. As a rule, the presence of the tumors has not been associated with pruritus. As they are usually part of the generalization of the disease, they are a late phenomenon in its course."

In regard to "*Diagnosis from Sarcomatous Lymphomas*", Rolleston states: "The greatest difficulty is the clinical differentiation of Hodgkin's lympho-granuloma from lymphosarcoma and the closely allied malignant lymphocytoma composed of small lymphocytes, and from endothelial sarcoma. I have seen cases apparently running the clinical course of Hodgkin's lympho-granuloma show these histological appearances. Finally, the question arises whether, as probably most would consider, these conditions have existed from the start, or whether they have supervened as the result of Hodgkin's lympho-granuloma. Is there any evidence of this change, such as a biopsy early in the course of the disease showing the appearances of Hodgkin's disease, and later a necropsy proving the sarcomatous nature? It does not appear to me that the therapeutic test of X-ray exposures helps in distinguishing them."

The most important clinical signs of Hodgkin's disease are the following. An enlarged gland usually appears first on one side of the neck and is followed soon after by other glands on the same side, after a few weeks or months similar enlarged glands appear on the other side of the neck, and still later, in the axilla and groin. The spleen or liver, one or both, are not infrequently enlarged. The clinical features of the enlarged glands are often sufficiently characteristic to enable one to make a diagnosis of Hodgkin's disease. The glands are freely movable, discrete and very seldom fused as is so often seen in tuberculosis. They are firm in consistence but less hard than a carcinomatous gland and less soft than a lymphosarcoma. In a number of cases, especially after generalization has occurred, there may be an irregular temperature as high as 102° to 103° F and lasting for weeks. There is nothing of diagnostic value in the blood examination. A severe and progressive anæmia is usually found in the later stages of the disease.

Prognosis of Hodgkin's Disease—There is no evidence of a spontaneous cure ever having occurred and the universal fatality of the disease has long been recognized. The duration of life varies with the individual case, probably due to variations in the resisting power of the individual and to the variations of the infective agent. It is also very definitely modified by different methods of treatment. Life has been very definitely prolonged by drugs, *e g* arsenic, and by rontgen-rays, radium and toxins of erysipelas and *Bacillus prodigiosus*. In nearly all cases, except a very small percentage, the effect of treatment gradually diminishes and finally becomes nil and the disease goes on to a fatal issue. One case is recorded by Schniffner (quoted by Rolleston), that survived eleven years under rontgen-ray treatment. Some cases run a very acute course causing death within a few months or a year in spite of all treatment.

The following is an example of the difficulty associated with the early diagnosis of Hodgkin's disease especially with a type of Hodgkin's disease which progresses rapidly toward a fatal ending and which shows practically little or no effect from either radiation or toxins.

CASE II—Mrs C W, female, aged thirty-seven years, was referred to me by Dr Donald Guthrie of Sayre, Pa, with the following history. The patient had been in good health until February, 1925, when she noticed a small lump in her neck, there were no enlarged glands elsewhere. The gland in the neck was at first believed to be tubercular and was treated for several months with rontgen-ray. In August, 1925, a biopsy was performed by Doctor Guthrie, who regarded the condition as one of tuberculosis. In spite of further rontgen-ray treatment, the glands of the neck continued to increase in size, and on October 13, 1925, Doctor Guthrie performed a second operation. By this time it had become evident that the condition was Hodgkin's disease, in an advanced stage, with involvement of the right cervical region as well. The patient soon began to lose flesh and developed a cough. Rontgen-ray and fluoroscopic examination showed undoubted evidence of thoracic involvement.

When the patient came under my care in November, 1925, there was definite enlargement of the cervical glands on the right side of the neck and extensive involvement of the mediastinal glands, associated with marked dyspnoea. She was losing flesh rapidly. She was immediately started on treatment with the mixed toxins of erysipelas and *Bacillus prodigiosus* and in addition two radium-pack treatments (9000 mc hours at 6 cm distance) were given in December, 1925, and February, 1926. The treatment had practically little or no effect in checking the rapid advance of the disease. The dyspnoea became more and more pronounced, and after suffering intense agony for two weeks, the patient died on February 20, 1926. This was one of the most rapidly progressing cases of Hodgkin's disease that I have ever observed.

Burnam, of Baltimore, in a paper on *Hodgkin's Disease*, *The Journal, A M A*, October 30, 1926, vol lxxxvii, No 18, reports the end results observed in a series of 183 cases of Hodgkin's disease treated at the Howard A Kelly Hospital between October 1913, and November 1925. In his introduction, Burnam states that his original intention "to cover both Hodgkin's disease and lymphosarcoma was abandoned on account of the immensely greater material and the difficulty in analyzing it, and also from the fact that the two diseases are histologically and, in many ways, clinically quite distinct. The first is an infection, in all likelihood, and the second a

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neoplasm I believe that a large number of cases which have been treated and which showed the general distribution in the glands, the fever and the other clinical signs of Hodgkin's disease, may have been Hodgkin's disease. The tissue examinations, however, showed only a lymphoid hyperplasia and, as a consequence, these cases have been classified as pseudoleukæmia, or lymphosarcoma." The latter part of Burnam's statement would lead one to believe that the difficulty in differentiating Hodgkin's disease and lymphosarcoma was somewhat greater than he admits.

Burnam's series corroborates the repeated assertion that Hodgkin's disease is more prevalent in males than in females, his group including 118 males and 55 females.

The age incidence in this group of 173 cases was as follows:

	Per cent
Up to 10 years	2.45
Between 10 and 20 years	15.33
Between 20 and 30 years	22.1
Between 30 and 40 years	22.3
Between 40 and 50 years	22.1
Between 50 and 60 years	10.4
Over 60 years	5.5

Burnam's series shows that in a great proportion of the cases the disease was apparently primary in the neck. He cites the place of primary gland enlargement as follows:

	Times	Per cent
Neck	149	86.1
Mediastinum	13	7.5
Abdomen	11	6.1

I believe that a very large number of cases that have heretofore been classed as primary neck cases, should have been classed as primary mediastinum cases, and that failure to take early roentgenograms until after nodules had appeared in the neck has been responsible for the error.

Regarding the course of the disease, Burnam states as follows: "Very acute cases, especially of the intestinal type, last only a few weeks, chronic cases, extending over years, have been long recognized and generally regarded as rare. Two years is the period most authorities give for the average cases, and five years as the extreme limit." The average duration of life in 155 cases of Burnam's series was one year and five months.

In regard to treatment, Burnam believes that surgical removal does no harm in the early localized affections, easily and quickly removed, but extensive operative removals, entailing prolonged anæsthesia, and wide exposures, are unsound theoretically and in practice, and are apparently frequently followed by rapid extensions of the disease. The treatment employed in this series of 173 cases was, with few exceptions, radium alone. A number of the patients had had preliminary surgical removals, but all such showed evidence of disease at the time of treatment. Some had had roentgen-ray treat-

ment, and in some instances it was stated to have been without benefit Burnam states, "I have recently been engaged in a comparative study of the two agents, radium and the rontgen-ray, and I am not able to state what the comparative ultimate results of the two methods will show I do find that the reduction of glands, whether deep or superficial, is much more rapid from the radium than from deep rontgen-rays, furthermore, the effects are obtained with much less general upset to the patients It seems that a very much smaller percentage of gamma rays is effectual than of rontgen-rays in producing similar results" Burnam points out that there are few conditions in which wider differences in susceptibility to radium are encountered than in Hodgkin's disease He states, "It is obvious that a mass composed of fibrous sclerotic tissue will not reduce so rapidly as one made up almost entirely of cellular tissue and particularly of lymphocytes, but quite aside from differences due to architectural material, there are other and unknown factors, whether in the virulence of the infecting agent or in the defensive forces of the body, which produce striking differences in response to any fixed amount of irradiation It is of paramount importance to begin with small doses and test out the results in each individual case When the disease is localized, the dosage may if it is necessary, be carried to several times that which is, on the average, effectual In contrast, when the disease is widespread and when incomplete results are obtained by moderate dosage, it is best to go slowly and to recognize that palliation is an end desirable in itself"

The technic which Burnam recommends is "a uniform distance of two inches from the skin, a filter of one millimetre of copper and one millimetre of lead in all the superficial gland areas, and in the deep areas, unless cross-firing is feasible, a distance of from four to five inches The dosage at the shorter distance is four gram hours, and at the greater from fifteen to twenty-five gram hours This is about 50 per cent of the erythema dose"

While Burnam believes that palliation is not to be discredited "and especially when it returns hopelessly ill people for months and even years to normal life, nevertheless I am convinced that certain cases of Hodgkin's disease are not only palliated but cured, from the clinical standpoint at least, and this is as far as one can go with any of the chronic infections, such as tuberculosis, or syphilis, or with any of the malignant new growths Furthermore, while it is possible clinically to cure very widely spread disease, the percentage of relief is much smaller than when the disease is limited to its original site" Of this series of 173 cases reported by Burnam, 110 patients have died of the disease Burnam has a group of twenty-eight patients whom he has classified as clinically cured, although two of them are dead, dying in the ninth year, in each instance from apoplexy The average duration of life in this group was six years and three months

The importance of beginning treatment as soon as possible after the disease has been recognized is shown by Burnam's end results Of the entire series of 173 cases, only twenty-four were localized to a single region, and

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of these fourteen are in the cured group of twenty-eight cases, twelve of these fourteen cases were cervical, one was mediastinal, and one was splenic. In the remaining 149 cases, only fourteen clinical cures were obtained, and none of these were in the very last stages, although six patients were very toxic and ill at the time treatment was undertaken.

W. S. Stone, of New York, in a report on two hundred cases of Hodgkin's disease treated by roentgen-ray and radium, at the Memorial Hospital, New York, states as follows:

In spite, however, of the extensive literature which has accumulated during the past twenty years, showing the undoubtedly favorable action of these agents, there is little discussion of the curability of Hodgkin's disease. There is also little in the literature to indicate the percentage of cases in which this mode of therapy is effective, the amount of palliation to be expected, and if actual prolongation of life has resulted. Such questions are especially difficult to answer because of the obscure nature of the disease, the location and multiplicity of its lesions and its varied course.

Regarding the permanent curability of Hodgkin's disease by these agents, our records indicate that palliation only can be expected. There are only five living without appreciable lesions or symptoms, one of whom has been well over four years. Three have remained well over three years, one only six months. One patient died after being well for over five years. It is of practical importance, according to the writer's experience, to accept its incurability as a fact in order to obtain the best palliative results. During our early experience a prompt and apparently complete regression of a chain of enlarged nodes led us, in the hope of producing a cure, to give prophylactic treatments over such areas, and also over areas where tumors might be expected to appear. Recurrent tumors, however, developed and new tumors appeared in the fields which had been treated prophylactically, applications to which were found to be less effective than when applied to areas which had not been previously treated. There also appears to be no other disease which requires, even for producing palliation, so many applications to so many areas, demanding, therefore, much consideration of the dosage, the choice of areas and the timing of the applications. The structure of the nodes, also, in Hodgkin's disease, is such that their reaction to these agents causes fibrosis and hardening of the tissues comparatively early, producing pressure upon nerves, blood vessels and neighboring organs, which may cause more distressing symptoms than originally existed. The deleterious effects of repeated and long-continued radiation are seen at autopsy upon these cases to the extent of widespread atrophy of the bone marrow. At present, therefore, we only apply the treatment to tumors as they appear, and often give more consideration to the possible effects upon normal tissues and the general condition of the patient than to the growth activity of the tumors in our timing of the applications.

Stone summarizes his views as follows:

1. X-ray and radium are only palliative agents in the treatment of Hodgkin's disease.
2. Palliation can be accomplished in 60 per cent of cases, and complete restoration of health with or without complete regression of the tumors may result in about 32 per cent.
3. Restoration of health will often last for a year and rarely two, three or four years.
4. Palliation, if it is to follow, will begin after the first or second treatment.
5. Life may be prolonged one or two years.

DIJARDINS and FORD (J. A. M. A., September 15, 1923, p. 925) report the end results in 135 cases of Hodgkin's disease and fifty-five cases of lymphosarcoma observed at the Mayo Clinic between the years 1915 and 1920. In every case the diagnosis was verified by microscopical examination.

Concerning treatment, they state as follows: "The only form of treatment that

exercises noteworthy influence on such morbid states is irradiation by means of roentgen-ray or radium used either independently or in combination. Even in the presence of extensive mediastinal glandular involvement, with or without pleural effusion, it is often possible for such adenopathy to disappear and the fluid to be absorbed. Unfortunately the improvement is not permanent, it may continue for a number of months or even two or three years, but sooner or later recurrences in the same or other places occur and are usually fatal. Evidently these authors were entirely unfamiliar with the results of treatment of Hodgkin's disease and lymphosarcoma by the mixed toxins of erysipelas and *Bacillus prodigiosus* reported at the American Surgical Association meeting in 1915.

Of the 135 cases of Hodgkin's disease reported by Dejardins and Ford the date of death was known in seventy-three cases. In these, the average duration of life was two years and seven months. In the fifty-five cases of lymphosarcoma, the average duration of life was found to be two years and three months. Of the entire series of Hodgkin's cases, seven (9.8 per cent) were well for five years or more, and of the lymphosarcomas, six (11 per cent) were well for five years.

In conclusion, Dejardins and Ford claim that while it is impossible to state that irradiation prolongs life, it is well known that in many cases it produces complete or partial control of the disease and adds greatly to the comfort and well-being of the patient.

In several instances these authors have noted a certain feature that I myself have observed in my experience with this type of disease, and that is, marked leucocytosis. In one of my cases of Hodgkin's disease, a blood test showed 83,000 white blood cells, and in one case of lymphosarcoma, there was found 247,000 white blood cells. While the latter case clinically resembled one of lymphatic leukemia, microscopical examination showed it to be a lymphosarcoma.

The statistics of MINOT and ISAACS, already referred to, cover 232 cases admitted to the Massachusetts General Hospital between 1901 and 1925, 225 cases observed at the Collis P. Huntington Memorial Hospital, of Harvard University, between 1913 and September, 1925, and twenty cases seen in private practice since 1916, making a total of 447 cases. Seventy-six patients are living and 401 are known to be dead. Of this entire series, only seven patients were alive ten years or longer after the date of first observation. These seven were classified as follows:

1 female (age group 5-9)

2 males, 1 female (age group 40-44)

1 male in each of the age groups, 45-49, 50-54, 65-69

Total 7, 5 males, 2 females. Of these, 4 were irradiated and 3 were not.

Forty-one patients had lymphoblastoma for six years or more before death, of which 11 per cent were treated by radiation, and 8 per cent were not so treated. Of the 401 cases known to be dead, 238 were treated by radiation, and 163 were not irradiated. The latter group includes thirty-three patients who underwent a surgical operation with removal of a considerable amount of diseased tissue. According to Minot and Isaacs, "The patients treated by surgical measures, whether or not they received roentgen-rays or radon, had lymphoblastoma on the average 3.67 years, or 1.11 years longer than the average duration (2.56 years) of the disease in the 334 not undergoing a therapeutic operation. The chances of the former living beyond three years from the time of their first symptoms were greater than for the whole group of irradiated patients. However, the percentage dying a year or less after the onset of disease was the same as for the cases given no especial treatment, and only 10 per cent less than for the latter group at the end of the two-year period."

The results of Burnam with radium are more favorable than any that have been obtained by other men. The fact that the majority of his series,

well five years, occurred in cases treated in the very early stages of the disease, emphasizes the great importance of early diagnosis and early treatment. It would seem to still further support the view of Professor Turnbull that the disease begins in a single focus and later is carried through the blood stream to other glands and soon becomes generalized. If we wait until this generalization has taken place, we can hope for little more than temporary control. If we can recognize the condition when the disease is limited to a single focus or to a few enlarged glands in a single region, then we are certain to control the disease for a much longer period of time and it is not impossible that we may effect a permanent cure.

This brings up the question of the value of surgery in Hodgkin's disease and lymphosarcoma. From my own experience I am of the opinion that an early biopsy is extremely important in most cases of enlarged glands, especially in young adults and especially when such enlargement cannot be easily accounted for by some adjacent focus of inflammation, *e g* in the throat or nasopharynx in the case of cervical glands. One must recognize frankly the fact, that it is extremely difficult to make a diagnosis from a small gland removed at biopsy between Hodgkin's disease or lymphosarcoma or simple hyperplasia. It has been my experience in three or more cases after having removed a gland from the neck in a case of suspected Hodgkin's disease or lymphosarcoma, to receive a microscopical report of chronic inflammation, no evidence of malignancy, and yet in each case the subsequent clinical history showed that it was a case of Hodgkin's disease or lymphosarcoma. In other words, in certain cases we shall still be in doubt after the biopsy report and in a case of negative report we must decide upon our diagnosis and treatment from the clinical evidence alone. Fortunately in the majority of cases of Hodgkin's disease or lymphosarcoma the pathologist will be able to make a positive report and this fact is what prevents us from losing faith in the biopsy and permits us to obtain most valuable help in the majority of cases.

If the biopsy gives positive evidence that the enlarged gland is Hodgkin's disease or lymphosarcoma, what is the best course to pursue? If it was a solitary gland and was completely removed in the biopsy, then it is my opinion that the patient should be put upon a course of roentgen-ray treatment and should receive systemic injections of toxins two or three times a week for a period of six months, in moderate doses that will interfere but little with his ordinary routine of life. If the gland was not solitary, but one of a few regional and well localized glands that apparently can be successfully removed by surgery, then I believe surgery should be performed, followed by prophylactic local treatment by radium and systemic toxins. In the more advanced cases in which several regions and glands are affected and especially if the roentgenogram shows the mediastinum to be involved, I believe surgery should not be tried. It can do little good and may do much harm by still further generalizing the disease.

A study of my own cases in which surgery was employed would seem to support the foregoing views

While I do not go so far as Bunting and Yates do¹⁴ in believing that the disease is strictly local in its origin, at least when the patient first consults a physician or surgeon, and, therefore, should be treated by radical surgical operation, I do believe with Stone as well as Minot and Isaacs, that in a few very early cases when the disease is apparently confined to one or a few glands, and these regional, surgical removal followed by local radiation and prolonged systemic toxin treatment offers the greatest hope of controlling the disease. This group of cases, however, represents a very small percentage of the total

Stone has pointed out the difficulty of the problem of adjusting the proper dose of radium to the individual case. No two cases are alike, and the dose that might be of great advantage to one patient might do great harm to another. In an advanced case with much fibrosis, radiation is of little value and may do positive harm, increasing the anæmia and lowering the general vitality. Minot and Isaacs and others have pointed out the dangers of too large doses of radiation in the acute highly cellular cases, and in a number of cases the evidence is very positive that radiation has hastened a generalization of the disease.

While I believe that radiation has proved of very great value in the treatment of both lymphosarcoma and Hodgkin's disease, the weight of opinion at present is that this method can be regarded as palliative only, and not curative, in the great majority of cases. It is true that Burnam's results show that in a considerable number of cases of Hodgkin's disease, radiation has kept the disease under control for a long period of time, sufficiently long to warrant classing the cases as cures. On the other hand, the statistics of Minot and Isaacs and of Stone, have not shown these lasting results either in lymphosarcoma or Hodgkin's disease. It is possible that Burnam's series covering, as it doubtless did, mostly private patients, may represent a higher percentage of cases in the early stages of the disease when radiation accomplishes much more than it does in the later stages. Furthermore, being private patients, they were under much better control, and treatment could be carried out much more satisfactorily than was possible in the series reported by Minot and Isaacs and by Stone representing almost entirely cases observed in the out-patient department. In view of these facts, we must admit that the present results in the treatment of lymphosarcoma and Hodgkin's disease are far from ideal, and I believe that the profession should welcome any aid that might be given to radiation, in the way of some systemic remedy or agent.

While this disease (or group of diseases) may be, and probably is local at the beginning, it is nevertheless true that it is far from being local when its true nature is recognized and treatment is begun. In the majority of cases instead of finding a solitary enlarged gland we find a large number

¹⁴ J. A. M. A., vol. Lxiv, p. 1953, June 12, 1915

of glands, and usually these are not confined to a single locality, like one side of the neck, but they involve the mediastinal, axillary, inguinal, and even the retroperitoneal or mesenteric glands as well. If this is true, it becomes apparent that the satisfactory treatment of all these glands, superficial and deep, by a local agent like radiation, becomes a very difficult and often impossible task. While radiation can accomplish much in the way of palliation in most cases, a cure or prolonged control of the disease is rarely obtained. In such cases I believe that systemic injections of the mixed toxins of erysipelas and *Bacillus prodigiosus* offer a very definite aid to local radiation of all the enlarged glands. That this opinion is based not merely upon theoretical considerations but upon actual results in a large number of cases treated before radiation was employed, has been shown in detail in my paper of 1915. Here we find that upward of 10 per cent of the cases treated by toxins alone have recovered and have remained well from three to more than twenty years. This would seem to be ample ground for advocating a combination of toxins and radiation.

In his paper already referred to, Burnam has stated that he has used the toxins extensively in Hodgkin's disease and found them to be of no value. It would be interesting to have a more detailed report from Burnam stating in how many cases the toxins were used, in what type and in what stages of the disease, and especially, whether the toxins were used alone or in conjunction with radiation and how long the treatment was continued. If used with radium, it would be extremely difficult to estimate the relative value of either agent. Were my series confined to cases treated by a combination of toxins and radiation, no matter how successful the results were, I should hesitate to say just what part the toxins played in accomplishing these results. However, we have a large group of cases of lymphosarcoma and Hodgkin's disease in which the toxins were used alone and in which it is impossible to attribute the favorable results obtained to any other agent.

If it could be shown that it is possible to obtain equally good results with radiation, there might be some reason for not employing the toxin treatment in lymphosarcoma, but no one has thus far reported any results from radiation that equal the results obtained from toxin treatment, either in regard to the number of successes or the durability of the cures.

While all the successes with the toxins have been obtained by the use of interstitial or intramuscular injections, I believe that it might be possible to obtain far better results from intravenous injections. Some fifteen years ago I tried intravenous injections in two or three cases, but owing to the severe reactions that followed I feared that this method might prove too dangerous and therefore abandoned it. About two years ago, at the suggestion of my son, Dr. Bradley L. Coley, I began again to use the intravenous method and we have used it in a considerable number of cases since. While we have not had any fatalities, we are not yet ready to advocate it as a routine method for the reason that very severe reactions often follow a minute dose (one-twentieth minim). The susceptibility of the different individuals varies

greatly In one case a dose of one-eighth minim injected intravenously was followed by a temperature of 104° or 105° F, while in another the temperature rose to 105.5° following an injection of one-twenty-fourth minim I have had a temperature of 104° follow an initial dose of one-fortieth of a minim in an adult The intravenous method should never be used until the susceptibility of the patient has been ascertained by the use of interstitial injections given over a period of at least one week The initial dose given intravenously should never be more than one-twenty-fourth minim A number of cases that have failed to respond to interstitial injections have shown marked benefit from intravenous injections, and I believe that the latter, if given with care offer greater promise of success not only in lymphosarcoma and Hodgkin's disease but in all types of inoperable sarcoma

REPORT OF CASES OF SPECIAL INTEREST

CASE III—*Hodgkin's disease or lymphocytoma, treated with toxins, radium and rontgen-ray Disease more or less under control for three and one-half years Death from pneumonia, autopsy* R McC, male, aged fifty-two years, came under my care on July 10, 1921, with the following history In the early part of 1920, while on a sea voyage, he first noticed a swelling under the chin, this lasted for three or four days It is interesting to note that other members of his family were affected in the same manner From that time on, the patient claimed that he had never really felt like himself again In the beginning of 1921, general weakness, which previously had not been so marked, became striking, and he suffered from an attack of lumbago also In April, 1921, the patient was shocked on noticing for the first time his extreme pallor, soon after this he experienced shortness of breath On May 13, 1921, he came under the care of Sir Humphrey Rolleston, whose report of the case is as follows "Patient when first seen had had dyspnoea for a month Pale aspect at first suggestive of chronic renal disease but urine normal, and blood pressure 165 systolic, 80 diastolic Enlarged discrete glands on right side of neck, enlarged irregular liver, doubtful mass about splenic flexure, no sore tongue X-ray report does not suggest carcinoma of stomach or colon Blood with low color index, otherwise suggests early pernicious anemia or secondary metastases in bones On May 30, after rest and arsenic, some improvement of blood and general feeling July 27, after moderate business activity, worse, glands were enlarged, gland in right groin, also gland in left side of neck *Rontgen-ray Examination*—May 17, 1921, report as follows 'Enlarged glands in root of right lung, heart enlarged' *Blood Examination*—May 13, red blood cells, 3,165,000, white blood cells, 4,400, hæmoglobin 57 per cent May 28, 1921, red blood cells, 3,370,000, white blood cells, 5,000, hæmoglobin 55 per cent June 27, 1921, red blood cells, 2,710,000, white blood cells, 4,800, hæmoglobin 43 per cent"

The patient came under my care on the day of his arrival from Europe on July 10, 1921 Physical examination at this time showed him to be very anæmic and cachectic, with evidence of marked dyspnoea on the slightest exertion Enlarged glands, discrete and fairly firm in consistence, were found in the cervical and supraclavicular regions as well as in the axillæ and groin The spleen was markedly enlarged, and the liver was enlarged to the extent of two finger-breadths below the border of the ribs My clinical diagnosis was that of Hodgkin's disease, primarily in the mediastinum Dr Evan Evans and Dr Karl M Vogel, both of New York, who saw the patient in consultation with me, concurred in this diagnosis I did not believe that he could live more than three or four weeks Doctor Vogel made a blood examination at this time and reported as follows Red blood cells 2,500,000, white blood cells 4,400, hæmoglobin 45 per cent In counting 300 cells, two megaloblasts and eight normoblasts and four microblasts were seen Abnormal white cells were not seen The red cells showed considerable

variations in size, very slight poikilocytosis and slight polychromasia. Punctate basophilia was not observed. *Röntgen-ray examination* at this time showed a large tumor in the mediastinum.

The patient was admitted to the Memorial Hospital on July 29, 1921, and a massive dose of radium (9000 mc hours at 6 cm distance) was immediately applied over the mediastinum. Four days later another massive dose of radium was applied over the spleen. He showed very little reaction to radium. Röntgen-ray treatment was given over the glands of the neck, axillæ and groin. In addition, he was put upon systemic injections of the mixed toxins of erysipelas and *Bacillus prodigiosus*, the initial dose being one-quarter of a minim. He proved very susceptible to the toxins and was never able to take a larger dose than three minims.

A gland was removed shortly after the patient's admission to the Memorial Hospital, and submitted to Doctor Ewing for microscopic examination. His report is as follows: "Chronic lymphadenitis, no definite signs of Hodgkin's. The cellular overgrowth is considerable but not enough for lymphosarcoma which it resembles."

As the clinical evidence of Hodgkin's disease or lymphosarcoma was so strong, little attention was paid to the negative microscopical report based upon the examination of a small gland. Seven weeks after the patient's admission to the hospital examination showed changes to have taken place which were very remarkable: all the glands had disappeared, and the spleen and liver had returned to normal. The blood picture, however, was distinctly worse, radiation having caused a fall in the white blood cells to 1,000, and the red blood cells to 2,210,000, hæmoglobin 33 per cent. A blood transfusion was given and was followed promptly by marked improvement. During February, 1922, his hæmoglobin remained stationary, with moderate fluctuations, in the neighborhood of 80 per cent, and his white-cell count was normal. No radiation was given during this period. He received only moderate doses of toxins ranging from $1\frac{1}{2}$ to 2 minims, which produced a slight reaction, temperature of 99.5, but no chill. In August, 1922, one moderate röntgen-ray (low voltage) treatment was given over the axillæ, neck and groin, and he received another transfusion on September 22, 1922.

Physical examination in November, 1922, showed distinct enlargement of the mediastinum. Röntgen-ray examination of the teeth revealed numerous abscesses about the roots, and two of the lower teeth were extracted. The effect of the last transfusion was very much less marked than that of the first, and was more temporary. He was becoming rapidly weaker, even slight exertion causing dyspnoea, his hæmoglobin had gone down to 45 per cent, his red blood cells to 1,800,000, and his general appearance was very anæmic. No glands could be felt in the neck or axillæ, the inguinal glands were palpable, and enlarged glands could be felt in both iliac fossæ.

He was given another transfusion of blood (750 cc). Two days later another radium-pack treatment was given over the iliac fossa and groin. Between November 15 and November 23, four more teeth were extracted. On December 5, 1922, the patient went to Camden, South Carolina. During the next month he showed steady and rapid improvement, he was able to play eighteen holes of golf a day without fatigue. In May, 1923, slight enlargement of the glands was detected in the cervical and axillary regions as well as in the groin, the retroperitoneal glands also were slightly enlarged. In June, 1923, a radium-pack treatment (9,000 mc hours) was given over the groin, and Röntgen-ray treatment to the other superficial glands. In addition the toxin treatment was resumed. *Röntgen-ray examination* at this time failed to show any evidence of enlargement of the mediastinum.

During the next eighteen months the patient received a transfusion every four or five weeks by Doctors Coley (B. L.) and Patterson. At first 600 or 700 cc were given, but this amount was later increased to 1,000 cc (from two donors). The last transfusion was given on December 6, 1924. It was necessary for the patient to travel some two hundred miles, in mid-winter, to get this transfusion and on the way he caught a slight cold, temperature of 100. He was kept in New York for one week until his

cold had apparently disappeared and his temperature had returned to normal, but on the way home he caught more cold, which developed into pneumonia and caused his death in two days.

An autopsy was performed by Dr Stanley T Fortune and the tissues were examined by Doctor Ewing, whose report is as follows:

"In all the organs from which slides re-submitted (liver, spleen and lung) I find a malignant tumor of the type of malignant small-cell lymphocytoma.

"The spleen section shows a diffuse growth of small lymphocytes obliterating all the normal structures of the organ. In the liver the infiltrations are limited to diffuse lymphomas of the portal canals, while the lobules are free. The lung tissue shows a solid growth of lymphocytes filling the alveoli, but not destroying the framework of the lung.

"This type of tumor is a rather rare but well recognized type of lymphoma, generally called malignant lymphocytoma. It is nearly always systemic, affecting the whole lymphatic system and eventually the organs. It is related to lymphosarcoma and to pseudo-leukemia, but differs from the usual type of lymphosarcoma, in that the cells are small lymphocytes. It is one of the most malignant tumors known. Of the causation nothing is known. I believe all such cases are fatal, without regard to the method of treatment."

This case is of interest from the fact that it shows a far advanced malignant process involving the lymphatic glands to have been kept under partial control for a period of three and one-half years, the patient then dying of pneumonia. According to the autopsy, however, the disease was steadily progressing and, undoubtedly, would have caused death in a comparatively short time even if the patient had not contracted pneumonia. The case further illustrates the importance of paying little heed to a negative microscopical report based upon an examination of sections from a small gland.

CASE IV—Round-cell lymphosarcoma of neck and supraclavicular glands, recurrent and inoperable. Patient well twenty-five years after treatment. A P., female, aged two years and ten months. This patient was referred to me by Dr E. J. McKnight, of Hartford, Connecticut, in March, 1902. A primary tumor had been removed by Doctor McKnight at the Hartford Hospital on January 27, 1902. No examination of the specimen was made, but the tumor rapidly recurred, and a second operation was performed in March, 1902. The specimen removed at this time was examined by Dr W. B. Steiner, pathologist at the Hartford Hospital, who made a diagnosis of small-round-cell sarcoma. The tumor was considered too extensive for removal. The patient was first seen by me on March 8, 1902, at which time I found a series of tumors extending from the clavicle to the mastoid bone on the right side. The submaxillary and axillary glands on the right side were also involved. The clinical appearance of the disease was typically sarcomatous. I advised the toxin treatment, which was carried out by Doctor McKnight for about three months. There was immediate improvement followed by complete disappearance of the tumor.

This patient was shown before the Clinical Congress of Surgeons of North America on November 12, 1912, and at a clinical conference at the Memorial Hospital on November 7, 1918. A letter received from her in 1927 stated that she was married, had four children, and was in excellent health.

CASE V—Inoperable melanotic sarcoma of the neck which entirely disappeared under an accidental streptococcal infection. Five years later developed round-cell sarcoma of the cervical glands which was treated with toxins and radium. The disease entirely disappeared and the patient is in excellent health thirteen years after the appearance of the melanoma. V. B., female, aged seven and one-half years. The patient had always been in good health until February, 1915, when a swelling of the left jaw was noticed. Two weeks later the right side of the neck began to swell and enlargement of the cervical glands was noticed. An examination was made by Dr W. F. Mercer, of Richmond,

Virginia, who pronounced the throat, nose and ears normal. The patient was then examined by Dr Robert C Bryan, of Richmond, Virginia, who found the submaxillary, cervical and supraclavicular glands symmetrically enlarged and matted together. The enlargement was more pronounced on the left side. A provisional diagnosis of Hodgkin's disease was made. The blood examination was negative.

On July 7, 1915, Doctor Bryan made a small incision over the submaxillary gland at the angle of the left jaw and removed two small glands. These were examined microscopically by Dr S B Moon, of the Medical College of Virginia, who made the following report:

"The sections are composed mainly of actively proliferating embryonal connective tissue cells, mainly spherical, but varying widely in shape and size. An occasional giant cell is seen. The vessel walls are thin or lacking, and when present, are intimately associated with the tumor cells. In some areas pigment granules, apparently melanin, are abundant in the cell protoplasm. Fibro-elastic tissue, fat, and striated muscle are definitely infiltrated by the tumor cells in their advance. *Diagnosis—Melanosarcoma*."

The condition was quite inoperable, and a hopeless prognosis was made. The tumor slowly increased in size until December 25, 1915, when there was also beginning emaciation. On December 26 the neck became red and swollen and continued to increase rapidly in size. The patient's temperature rose to 106° F and her pulse was 180. There was marked cyanosis, great dyspnoea and evidence of severe infection in the tumor. On December 27, the child became unconscious. On the following day, under primary anaesthesia, a median incision was made under the jaw and a large amount (from two to three ounces), of sero-pus was evacuated. A specimen was examined microscopically by Doctor Moon, who reported as follows: "Pus from neck is streptococcic with various saprophytes."

The infection slowly subsided but the wound remained open for several weeks. The tumors of the neck gradually decreased in size and in a short time entirely disappeared.

Doctor Ewing made a microscopical examination of the sections and confirmed the diagnosis of melanoma.

The patient later came to New York and was placed under my care for observation. She was presented before the New York Surgical Society on March 12, 1919.

In May, 1920, or five years after the appearance of the melanoma, she developed a rapidly-growing sarcoma involving the right cervical glands. A clinical diagnosis of round-cell sarcoma was made. I removed a portion of the tumor and submitted it to Doctor Ewing, who stated that it was a round-cell sarcoma with no pigment.

The toxin treatment was begun and kept up for four months. In addition, she received one radium treatment (2972 mc hours in the form of a lead tray placed at 3 cm distance). The tumors rapidly disappeared and the patient made a complete recovery. She was shown at a staff conference at the Memorial Hospital on January 28, 1926, at which time she was in excellent condition, eleven years since the disappearance of the melanoma and nearly six years after the disappearance of the round-cell sarcoma. At the present time, August, 1928, the patient remains in excellent health.

CASE VI—Large, inoperable lymphosarcoma of the small intestine treated with toxins and radium. Later metastases developed in the axilla. Patient in good health ten and one-half years later. R T, male, aged thirty-four years. The patient's father had died of cancer of the stomach. The patient had always been in good health until July 3, 1916 when he fell from a building, for a distance of eighteen feet striking on a cement floor, he landed in such a position that his upper abdomen received a sharp blow from his doubled-up elbow. Six or seven months later he began to feel pain in the upper left abdomen at the site of the injury. He consulted a number of physicians and surgeons in the State of Washington, who made the following different diagnoses: floating kidney, enlarged spleen, pancreas, sarcoma, tuberculosis of peritoneum, etc. The patient's own diagnosis was 'internal cancer'. In the middle of December, 1917, he came under the care of Dr Charles H Mayo, who made a clinical diagnosis of lymphosarcoma of the small intestine. Doctor Mayo performed an exploratory operation, by a left rectus

incision, revealing a large, inoperable tumor of the mesentery and small intestine. The tumor involved such a large segment of the mesentery that it was deemed unwise to attempt to remove it surgically and the wound was closed. The patient was then referred to me for toxin treatment.

Physical examination on January 7, 1918, showed a recent cicatrix, four inches long, over the left rectus muscle, the upper area of which was not entirely healed. Just underneath this incision was a solid tumor, about eight inches in diameter, deeply attached, but apparently connected with the mesentery or intestine. No enlarged glands could be felt. The patient's general condition was good, he had no pain nor any marked loss of weight. The blood test was negative.

The patient entered the Memorial Hospital and treatment with toxins and radium combined was begun at once. On January 8, 1918, he received his first radium-pack treatment consisting of 20,000 mc hours applied at 10 cm distance, on February 7, 1918, a second pack consisting of 16,000 mc hours was applied at 10 cm distance, and on March 3, 1918, he received 10,000 mc hours at 7 cm distance. He was made very ill by the radium.

On January 15, 1918, the toxin treatment was begun. It was given in small doses and increased very slowly, as the patient proved very susceptible and developed a high temperature, 103° , from a dose of two and one-half minims. After the first week's treatment, the tumor decreased about one-half in size and became much more mobile. The patient's condition steadily improved and he returned to his home on the West Coast, where the toxin treatment was resumed by his family physician.

On July 23, 1918, he again came to see me. Examination at this time showed on palpation, a very small, hardly perceptible mass at the site of the original tumor. As a precaution he was given two applications of radium (18,000 mc hours at 7 cm distance, each), and the toxin treatment was continued. During the year 1919 he received further applications of radium, totaling 44,283 mc hours. The toxin treatment was kept up by his family physician, two or three injections a week being given, in doses not sufficiently large to interfere with his daily routine of life. I saw him again in May, 1920, at which time physical examination failed to reveal any definite mass in the abdomen, there were, however, two very small glands in both cervical regions. The lead tray, containing 3,000 mc hours of radium, was applied at 3 cm distance to each area, and the pack, (17,000 mc hours), was applied over the abdomen. I next saw the patient on November 25, 1920, when he again had the pack, (6,344 mc hours), applied over the abdomen. The toxin treatment was continued. He received no further radium until August 8, 1921, when the lead tray containing 2,870 mc hours was applied to the left supraclavicular region, and the pack, (6,344 mc hours), was applied to the abdomen. In January, 1922, a small nodule was noticed on the left elbow. This was treated with roentgen-rays and disappeared. In January, 1923, he received another pack treatment (18,026 mc hours), over the abdomen.

The toxin treatment was kept up until November, 1923, after which the patient refused to take it any longer. About two months later, he noticed a slight enlargement of the glands of the left axilla, which steadily increased in size. I again saw the patient on January 20, 1925, at which time physical examination showed enlargement at the site of the old intraabdominal tumor, with apparent involvement of the retroperitoneal glands, the cervical and inguinal glands were normal. In the left axilla was a mass about the size of a large goose egg or a small orange, soft in consistence, movable and extending from some distance beneath the edge of the pectoral muscle. The radium pack was applied as follows. On January 22, 1925, he received 12,000 mc hours over the abdomen at a distance of 10 cm, on January 24 he received 10,000 mc hours over the left pectoral region, at a distance of 10 cm, and on January 26, he received 10,000 mc hours over the left axilla, at a distance of 6 cm.

On February 4, 1925, he entered the Hospital for the Ruptured and Crippled, where I removed the tumor of the axilla surgically. Microscopical examination proved it to be a typical lymphosarcoma.

This case is of interest for the following reasons first, it shows that a rapidly growing lymphosarcoma of the small intestine has been almost completely controlled for a period of ten years, the patient remaining in good health during most of the period, second, it shows that even when metastases have developed, one should not abandon treatment. In this case, the metastatic tumor in the cervical glands completely disappeared under further treatment. The latest and most extensive metastasis in the axilla did not occur until November, 1923, some time after the toxin treatment had been discontinued. While in all probability the disease will prove fatal in the end, I believe there is a reasonable hope of keeping it under control for some considerable time to come. I do not believe this result could have been obtained by toxins alone or radium alone, but was due to the combined treatment with both agents.

CASE VII—*Lymphosarcoma of neck, or Hodgkin's disease, treated with toxins. Patient well twelve years later, when she died of another trouble.* S. K., female, aged fifty-five years, was referred to me in December, 1913, by Dr. Arpad G. Gerster, with the following history. A tumor had been removed from the right side of her neck at Gouverneur Hospital nine years before. In March, 1913, a second operation was performed by Doctor Erdman for a local recurrence, the tumor removed weighed three-fourths pound and was pronounced lymphosarcoma by the pathologist of Bellevue Hospital. The tumor again recurred in the fall of 1913 and the patient was then referred to me by Doctor Gerster as an inoperable case.

Physical examination at this time (December, 1913) showed several tumors occupying the right cervical region between the mastoid and clavicle, varying in size from a hickory nut to a hen's egg. The tumors were smooth in outline, freely movable, more or less discrete, skin not adherent, consistence only moderately firm, no glands in either axilla or groin. No enlargement of the spleen or liver. The patient was put upon the mixed toxins of erysipelas and *Bacillus prodigiosus*. She proved very susceptible, the highest dose given being 5 minims. After fifteen treatments, the tumors had diminished markedly in size and became more freely movable, so that I believed it wise to attempt their removal by operation. This was done by my associate, Dr. William A. Downes, on January 15, 1914. Doctor Ewing's report on the specimen, dated January 15, 1914, reads "Typical Hodgkin's disease, granuloma, giant cells, hyaline and fibrin areas."

The disease recurred shortly after the operation and grew more rapidly than before. She was then put upon roentgen-ray treatment, under which there was marked diminution in the size of the tumor.

After her discharge from the hospital I lost track of the patient and believed she had died. Eight years later I was called in consultation to see her and found her suffering from an acute abdominal trouble (probably gall-bladder). She was removed to the Memorial Hospital, but her condition was too advanced for operation and she died in a few days. There was no evidence of any return of the Hodgkin's disease.

CASE VIII—*Far advanced Hodgkin's disease, diagnosis confirmed by microscopical examination, disappearance of lesions under toxins and radium. Patient well four and one-half years.* F. A. T., male, aged fifty-seven years. The patient's family history was negative. He had always been in good health with the exception of an attack of typhoid fever thirty-two years previously. His present illness started with a cough in the summer of 1921, for the next seven or eight months he felt very tired and weak. At the end of this time he noticed a lump in the left side of his neck. A diagnosis was not made until March 1, 1922, when a gland was removed and examined by the pathologist of the Buffalo Hospital for Malignant Disease, who pronounced it Hodgkin's disease. In the early part of March, 1922, he received roentgen-ray treatment of his neck. Shortly

afterward the glands in the right side of the neck and supraclavicular region began to enlarge. There was steady increase in size and the patient became weaker. Under further radiation the glands regressed somewhat. He was referred to me by Dr R P Huyck, of Herkimer, New York, and was admitted to the Memorial Hospital on April 24, 1922.

Physical examination at this time showed a well-developed but poorly nourished male. The cervical, axillary and inguinal glands were all enlarged, firm in consistence, discrete and movable. There was a mass of glands on the right side of the neck, the largest just above the clavicle measuring one inch in diameter. The skin was not involved. On the left side of the neck was a similar gland just under the scar. The liver was palpable, and the spleen just palpable.

Rontgen-ray examination by Doctor Herendeen, April 24, 1922. "Plate of chest reveals a diffuse haziness through the right side with some infiltration in the right hilum."

On April 26, 1922, the radium pack (12,750 mc hours) was applied over the mediastinum, at a distance of 10 cm. In addition, from May 4, 1922, to May 9, 1922, the patient received four exposures (fifteen minutes each) of rontgen-ray to the axilla and groin. At the same time, treatment with the mixed toxins was begun and continued in gradually increasing doses during his three weeks' stay at the hospital. This was continued at home by his family physician, Doctor Huyck. A few weeks after his discharge from the hospital his general condition became very weak, in appearance he was almost cachectic, and he was strongly opposed to any further treatment. I saw him again and finally persuaded him to go on with the toxin treatment. This was kept up for six months. In early June, 1922, he began to show some evidence of improvement in his condition, this continued until at the end of two months all trace of the disease had disappeared, he had regained his normal health and was able to return to his work. I saw him from time to time and found him in excellent condition. Physical examination in May, 1926, showed apparently no evidence of the disease.

In June, 1926, he developed a tumor in the left hypochondriac region which was regarded by several surgeons, who were not acquainted with the patient's early history, as a tumor of the kidney. This was, undoubtedly, a tumor of the spleen. It increased rapidly in size, his general health began to deteriorate, and in spite of further treatment, he died on August 1, 1926.

In this case I think it is fair to assume that the treatment added four years to the life of the patient, who was in an advanced stage of the disease when the treatment was begun.

My later series of cases personally observed since 1915 includes fifty-eight cases of lymphosarcoma and thirty-nine cases of Hodgkin's disease. In the former group there were thirty-five males and twenty-three females, and in the latter twenty-two males and seventeen females.

Age incidence

	<i>Lymphosarcoma</i> Cases	<i>Hodgkin's Disease</i> Cases
From 1 to 10 years	2	3
From 11 to 20 years	9	1
From 21 to 30 years	11	9
From 31 to 40 years	7	9
From 41 to 50 years	18	4
From 51 to 60 years	4	6
From 61 to 70 years	3	3
Not stated	4	4
	—	—
	58	39

HODGKIN'S DISEASE AND LYMPHOSARCOMA

Locality in present series

	<i>Lymphosarcoma</i> Cases		<i>Hodgkin's Disease</i> Cases
Neck	24	Neck	3
Retroperitoneal region	7	Groin	3
Axilla	3	Neck, axilla and groin	27
Groin	4	Supraclavicular region	1
Mediastinum	2	Cervical region	1
Tonsil	1	Mediastinum	1
Nasopharynx	2	Spleen	1
Multiple	15	Submaxillary region	1
		Multiple	1

Duration of symptoms in present series

	<i>Lymphosarcoma</i> Cases	<i>Hodgkin's Disease</i> Cases
Less than 1 month	3	—
5 weeks to 3 months	7	5
3 to 6 months	13	6
6 months to 1 year	11	12
1 — 2 years	12	4
2 — 3 years	6	4
3 — 4 years	1	2
4 — 5 years	2	2
6 — 7 years	1	—
8 years	—	1
9 years	1	—
Not stated	1	3

An analysis of the cases that have remained well for five to twenty-two years may be of some interest (four others were well for three to five years). Of this group fifteen were treated with toxins alone and three with toxins and roentgen-ray. This does not include a case of Hodgkin's disease that was treated with toxins alone by Dr. Charles E. Preston, of Ottawa, Canada, my old house surgeon, this case, which was well when last traced, twelve years later, might well be included here, as the treatment was carried out under my direction.

Site of Primary Tumor in Cases of Apparent Cure

	Cases
Glands of neck	10
Tonsil and neck	2
Axilla	4
Mediastinum	1
Groin	1
Mesentery and small intestine	1
	—
	19

The diagnosis was confirmed microscopically in all these cases with the exception of one a very large tumor of the mediastinum which disappeared under toxins and roentgen-ray and had not recurred five years later when the patient was last seen.

One case was included in my earlier paper, in which, while not strictly speaking, a lymphosarcoma, was, apparently, a primary malignant tumor of the lymphatic glands

This patient, the wife of a physician in Louisville, Kentucky, was referred to me in December, 1914, with an inoperable, four-times recurrent tumor that involved the cervical glands on both sides. While a microscopical diagnosis of melanotic sarcoma had already been made, I removed a gland for further study, and it was pronounced a malignant melanoma by Dr. James Ewing. I regarded the prognosis as quite hopeless but decided to give the patient a trial of toxin treatment. The injections were continued for nearly a year at home by her husband. Under this, and no other treatment, she made a complete and uninterrupted recovery. She remained well for more than nine years and then died of an independent trouble.

Of the thirty-nine cases of Hodgkin's disease included in my later series, only three remained well for a period of more than three years, and one of these died of the disease four years after the treatment was begun. Of the fifty-eight cases of lymphosarcoma, six remained well for a period of from three to ten years, two of these died a little over three years later, and the patient who has lived for ten years has marked evidence of the disease and is not expected to live much longer. One other case, No. VII (reported in my earlier paper, at which time the end result was not known) remained well for eight years and then died of another trouble.

A comparison of the results obtained in the later series with those of the earlier series will show the latter—in which treatment for the most part consisted of surgery and toxins—to be considerably better than those of the more recent series, in which treatment consisted of toxins and radiation. I think that the less favorable results obtained in the later series may be accounted for by the fact that most of these patients at the time of first observation were in a much later stage of the disease, the latter having become widely generalized in most cases, and most having been previously treated by radiation.

CONCLUSIONS

- 1 Lymphosarcoma and Hodgkin's disease should no longer be regarded as absolutely hopeless from any method of treatment.
- 2 These tumors are as a rule extremely radio-sensitive and are likewise responsive in a remarkable way to treatment with the mixed toxins of erysipelas and *Bacillus prodigiosus*.
- 3 It would seem logical to use the combined treatment, thereby securing the advantage of the local effect of radiation (radium or rontgen-ray) and the systemic effect of the toxins which have the power to reach hidden and remote glands beyond the reach of radiation.
- 4 These patients should be kept under the closest observation for a long period of time, and treatment should be kept up periodically for a number of years, especially in those cases in which the disease was generalized when treatment was begun.
- 5 Cases of lymphosarcoma so treated should show a cure or at least a

complete control of the disease for a long period (five years or more) in a very considerable number of cases, *i.e.* 10 to 15 per cent

- 6 Typical cases of Hodgkin's disease still show a very bad prognosis, and permanent control can be expected in only a very small number of cases

DISCUSSION DR HOWARD LILIENTHAL, New York City, remarked that in the treatment of lymphosarcoma and other forms of sarcoma he had found Coley's fluid to be of especial value in lymphosarcoma. Cases that he had had, for instance, had gotten well with Coley's treatment alone, with recurrence years afterward, and then a second cure by Coley's fluid with eventual apparent permanent cure.

He called attention to the fact that Coley has antedated Blair Bell in giving to the profession something which acts, as we may say, constitutionally instead of locally, as X-ray and radium do. Two years ago a young woman with Hodgkin's disease came to him with an enormous tumor of the mediastinum, which was proven to be Hodgkin's disease by the removal of a lymph-node from the neck. She was suffering from the usual symptoms of intense mediastinal pressure, the dyspnoea, the suffusion of the face and enlarged veins of the head and upper part of the thorax. He advised treatment by X-ray, although she had been given up entirely by the physicians at the Memorial Hospital in New York and had been sent home to die. Nevertheless, under X-ray treatment alone, there was in an astonishingly few weeks a complete disappearance of the symptoms of thoracic malignant disease, so that the chest appeared normal by X-ray and on physical examination. Now, after two years, she remains apparently perfectly well.

DR CHARLES N DOWD, New York City, said that he had seen a good many cases of Hodgkin's disease. He had not seen so many of lymphosarcoma of the neck. They usually had come to him with tremendously distended necks. Among these cases he had two who have now lived, one as nearly as he could remember about fourteen years, and the other about ten years.

The surgical operation—which, after all, is not very difficult, because Hodgkin's-nodes come out very easily—has been repeated on one case three times, and there has been very good radiation carried on. The other case was treated also by radiation and by surgery. The fact that he had two of those cases alive after this long period and the fact, as Doctor Coley tells us, that cases who have been treated by surgery have a longer expectation of life than those who have not, would lead him to believe that surgeons ought to endeavor to give these patients the advantage of surgical operation at an early stage in the disease.

The enlargement usually begins in a small group of lymph-nodes on one side of the neck. When one can get hold of them in fairly early stage, one may well believe that surgery offers more than has generally been supposed

If the palpable nodules are removed and then the locus subjected to such further treatment as seems wise, we are doing the best for our patients

DR LEONARD FREEMAN, Denver, Col, mentioned the case of a man with bleeding from the stomach, pain after eating, loss of flesh, and general disability, upon whom he operated and found two apparently distinct conditions. One was an indurated ulcer near the pylorus and the other an extensive involvement of the distal one-third of the stomach and first part of the duodenum, with a soft, whitish, uniform thickening. There was also enlargement of the glands above and below the stomach, and around the pylorus and aorta—soft, yellowish-white glands as large as the last joint of a thumb.

It did not appear that a resection of the stomach would be of any value as regards cure, but it seemed necessary to relieve him from his symptoms, so the entire pyloric end of the greatly thickened stomach was removed, it being necessary to go directly through the growth, both on the duodenum and the body of the stomach itself. After the operation was done, the recovery was uninterrupted. A pathologic examination of the specimen showed it to be a lymphosarcoma, examination being made not only by the Denver pathologists, but a specimen being sent to Doctor Mills, at the Mayo Clinic, and also to the Columbia University, in New York, and pronounced lymphosarcoma in all instances. The patient was then put upon Coley's toxins and the deep X-ray but carried out the treatment for a short time only regarding it as unnecessary owing to his rapid improvement. At the present time he is apparently perfectly well. He has no stomach symptoms whatever thirteen months after he was operated upon. He is virtually normal except that his weight is somewhat less than it was, and there are some enlarged glands in his neck and groins which have decreased in size and seem as though they were about to disappear.

In spite of the diagnosis of lymphosarcoma made by the various pathologists, the question of Hodgkin's disease must be considered, especially in the light of the close connection of the two affections so strongly emphasized by Doctor Coley.

DR WILLIAM B COLEY (in closing) remarked that if one could get early cases of single isolated glands, of the type in which Burnham had most of his successes, and, after removing the glands by surgical operation, give the patient a course of prophylactic toxin treatment, alone or combined with radiation, that a larger percentage of cures will be obtained.

He remembered a case that Dr Charles H. Peck referred to him some fifteen years ago. Doctor Peck had operated upon a large tumor in the region of the submaxillary gland, performing what he regarded as an incomplete operation, and then turned the patient over to Doctor Coley for toxin treatment. The gland removed was examined by the pathologist of the Roosevelt Hospital and pronounced to be a lymphosarcoma. On reviewing the section later on, after the patient had recovered, the pathologist stated that he was in doubt as to whether it was a lymphosarcoma or Hodgkin's disease. The slide was mailed to Doctor Welch, but, unfortunately, was lost in transit. At

any rate, the patient was alive and well twelve years later, and it does not matter very much which of the two diagnoses was correct.

He had another case, a girl aged eight years with a glandular tumor of the neck believed to be lymphosarcoma. It was impossible to perform a complete operation, but a portion of the tumor was removed and submitted to Doctor Ewing, who pronounced it to be a round-cell sarcoma. One single dose of radium was given, supplemented by toxin treatment for several months. This patient is alive and well over eight years later. A full history of the case will be found in the text of Doctor Coley's paper.

It is very important to make a diagnosis early, and not wait until the end result has determined the nature of the condition. In order to make an early diagnosis, a gland should be removed at once and examined microscopically.

One of his most remarkable cases of lymphosarcoma of the neck occurred in a child aged two and one-half years. The whole side of the neck was involved, and the condition was pronounced inoperable by Dr. Walter R. Steiner, of Hartford, one of the leading pathologists of Connecticut. Under toxin treatment alone the patient made a complete recovery and is well at the present time, twenty-six years later.

The first illustration of the beneficial effects of the toxins in Hodgkin's disease occurred at the Memorial Hospital some eighteen years ago. The patient had all the clinical earmarks of Hodgkin's disease—markedly enlarged glands of the neck, cervical and axillary regions and groin, with enlargement of the spleen and liver, accompanied by a persistent fever, temperature of 102–03°. In this case he removed one of the glands, which was examined microscopically by Doctor Ewing, and pronounced a typical Hodgkin's (which was the clinical diagnosis of Dr. W. K. Draper). Under six weeks' toxin treatment all the glandular tumors disappeared, the spleen and liver returned to normal size, and the patient gained twenty-six pounds in weight, in fact, he felt so well that he refused further treatment and returned to work. Within less than a year the disease recurred. The patient would not consent to further treatment and died about six months later. If the toxins alone can accomplish what they apparently did in this case, in which there was no doubt of the correctness of the diagnosis, why should they not be employed as a systemic agent in practically all cases of Hodgkin's disease?

HÆMANGIOMA OF CHEST WALL

By HENRY H M LYLE, M D

OF NEW YORK N Y

CASE REPORT—A woman aged twenty, was admitted to the Surgical Service of St Luke's Hospital, New York, October 25, 1927, with the following history

Three years ago without known cause a soft painless swelling suddenly appeared in the second right intercostal space close to the sternum. At first this swelling was only noticed when she bent forward or on standing erect, on lying down it disappeared completely. During the last year and a half the swelling has been growing larger and does not now completely disappear on lying down. In addition a small hard nodule has appeared in the swelling. The nodule is tender and at times cannot be found, at other times when caught it will suddenly slip from between the fingers and disappear. The patient noticed that when the nodule is absent the swelling is larger.

Examination revealed in the second right intercostal space two fingers breadth from the edge of the sternum a soft lens-shaped swelling, 3 by 2½ inches, with indefinitely defined borders. It is attached to the deeper parts, the skin is freely movable over it and there are no signs of discoloration or surface heat. Pressure does not influence the size of the mass but posture does. In the erect or prone position the swelling is diminished, on bending forward the tumor quickly resumes its usual size. When the mass is shrunken a hard round body about one-eighth inch in diameter can be felt, the nodule is suggestive of a bony or cartilaginous fragment. At times it slips from the fingers and seems to disappear between the ribs. Coughing slightly enlarges the swelling, it does not pulsate, no thrill is felt and no murmurs are heard. The mass gives the impression of being a cold or a latent bone abscess which connects with the thoracic cavity. The X-ray studies show an indefinite shadow three by four inches apparently in or just behind the anterior thoracic wall. The nature of the shadow was cleared up at operation. Plates taken after the operation failed to reveal it.

The patient was shown before the Surgical Conference and various diagnoses were made. The majority favored a cold abscess communicating with the thoracic cavity, a lipoma or a dermoid cyst communicating with the chest cavity.

At the operation a shirt-stud hæmangioma was found, the superficial lens-shaped expansion lay just beneath the pectoral fascia, the deep expansion lay between the pectoralis major and the intercostal muscles. The stem of the collar-button connecting the deep and superficial portions was composed of a dilated varix which contained a hard ivory-like phlebolith. The deep portion of the hæmangioma communicated by several branches with the vessels of the thoracic cavity. The phlebolith which was situated in the stem of the collar-button moved forward and backward like a ball-valve. When the patient sat erect it slipped backward and blocked the main communicating vessels, the same check-valve effect was produced when the patient lay on her back. On bending forward the phlebolith slipped into a side expansion and allowed a reflux of blood from the posterior to the anterior expansion. The operation was performed under local anæsthesia and the mechanism of the filling and the action of the phlebolith could be readily observed. The hæmangioma was excised *en masse* and its communicating branches to the thoracic cavity ligated. There have been no signs of recurrence and the patient has worked steadily since the operation.

DIVISION OF THE VAGI FOR PYLOROSPASM

BY CHARLES H. MAYO, M. D.

OF ROCHESTER, MINN.

It is nearly fifty years since Billroth directed the attention of the medical world to the possibility of relieving, by surgery, obstruction of the pylorus due to gross ulcer. The preantiseptic period with its attendant mortality was marked by many changes in technic and methods. These changes became fewer with the advent of antiseptic and later aseptic surgery. Greater effort was made and greater success was attained in relieving symptoms and in curing ulcer than in finding the cause of ulcer. Such ulcers were called "peptic", a term which was self-explanatory as indicating the theory that they were caused by the local action of pepsin activated by acid but probably starting at the site of a few dead mucous cells.

Recently several methods of producing gross ulcers of the stomach and duodenum experimentally have been successful. One of these is that reported by Rosenow, who has produced hemorrhagic patches and erosions by injecting intravenously into animals bacteria that have been cultivated from excised ulcers of the stomach and duodenum of human beings. The bacteria show a fairly definite selectivity in their localization. There is a strong tendency, however, for such lesions to heal rapidly perhaps because the experimental animals are, of course, not subject to any factors for the development of ulcers other than the injected bacteria. The ulcers do not heal so readily if the general health of the animal is broken by the production of local foci of infection. This may be accomplished by infecting the teeth and thus developing periapical infections and excavations in the bone. Such local foci continue to feed bacteria into the circulation after the ulcer has been created by the intravenous inoculation.

Another method has been developed by Mann, who has caused ulcers to form with great certainty from mechanical deflection of the digestive fluids of both stomach and duodenum, by short-circuiting through an anastomosis of the duodenum into the ileum thus preventing all secretions poured into duodenum from passing through the jejunum. By dividing the pylorus and uniting the stomach to the upper end of the jejunum thus allowing all of the contents of the stomach to pass into the jejunum. Mann has succeeded in producing ulcers, a large proportion of which are formed just distal to the suture line of the gastrojejunal anastomosis.

From these experiments it would seem that there are undoubtedly several factors connected with the development of gastric ulcers. We must remember, however, that mechanical injuries of the stomach and bowel usually heal

rapidly without ulceration. It would seem, therefore, that there must be some other factor in the maintenance of chronic gastric ulcers.

Any large series of necropsies on the bodies of adults who have died from any cause shows that it is not uncommon to find the evidence of healed ulcers in the duodenum or in the stomach. These ulcers appear to have been healed for long periods. In many of these cases a history suggestive of gastric or duodenal ulcer, may not have been elicited and the relatives of the deceased are not able to recall any symptoms suggesting ulcers which the deceased may have complained of during life. It is highly probable, therefore, that many people have hyposensitive areas in the stomach while others have hypersensitive areas. Some patients who have ulcers in these areas complain very little and others very much. It has often been noted also that patients who have suffered repeatedly from attacks of ulcers of the stomach and duodenum and have been operated on two months or so after the last attack has ceased, are found to have open ulcers which from their appearance would lead one to believe that they should be causing pain. But they are not really producing pain any more than are the old so-called varicose trophic ulcers on the lower half of the leg which may have been open for weeks, months, or years. Trophic ulcers on the ball of the foot or on the heel also may be painless. Such ulcers, however, from time to time may become exceedingly painful. At such a time a little red spot is noted on one side of the circumference of the ulcer. This very slight marginal extension may cause great pain and disability lasting at least two weeks.

It would appear then, that except in the presence of a deranged nervous (trophic) influence, both incisions and ulcerations in the body should heal. Is it not possible, that in the stomach the influence of the vagi in the chronicity of gastric ulcers has been overlooked? It is to stimulate observation in this direction that I am presenting this brief study.

Excellent studies by M'Crea and Brandt have shown that the pylorus and duodenum get their nerve supply from a large branch of the vagus that goes directly from the region of the cardia to the liver.

There is apparently some association between chronic appendicitis, diseases of the gall-bladder and ulcers of the duodenum and stomach. Just how it is brought about is not known, but when any one of these three structures is suspected of disease all three should be examined, especially in adults.

It is quite probable that the appendix comes first in the development of symptoms during contraction and spasm of the circular fibres, in a structure in which the wall is as thick as the rest of the bowel but with a very small lumen. The secondary influence may be on the outlet of the common duct, spasm of which may enormously reduce the amount of bile passing into the duodenum, thus causing excess of filtration by the gall-bladder. The influence of both appendicitis and gall-bladder disease on the pylorus is to produce pyloric spasm and it is probable that neither duodenal nor gastric ulcer occurs except when it is accompanied by pyloric spasm. May not, perhaps, the pyloric spasm precede the ulcer?

For the last two years in several cases in which it was evident that the trouble in the stomach was reflex, that is, spasm of the pylorus, whether secondary to appendicitis or disease of the gall-bladder or both in addition to relief of the particular disease found, I have divided the muscle of the pyloric ring at the upper border in some cases also cutting away the superior attachment of the first 2.5 cm. of the duodenum and the last 2.5 cm. of the pylorus in the hope of separating the branches of the vagus at this point. I have doubly ligated and have divided between the ligatures 2.5 cm. above the pyloric ring on the side of the lesser curvature into the wall of the stomach so as to be sure to divide the branches of the vagi. More recently in discussing this problem with men who are examining the stomach ontogenologically, the fact was brought out that ulcers in the angle of the stomach cause the greatest spasm of the pylorus. Since then I have divided above the angle of the stomach the tissues of the lesser curvature well into the wall of the stomach, instead of as formerly at 2.5 cm. above the pylorus. It would seem to me that this slight addition to gastro-enterostomy or to other operations for the relief of reflex conditions has been of some benefit, but it will take observation of many cases and observations of many men in such conditions before much can be said as to the possible benefit to be derived from the procedure.

Certainly we know little concerning the exact functions of the involuntary nervous system which has a regulatory effect on all of these structures. What has been done in the past has been of great help but none of us is satisfied that we have reached the full acme of our surgical procedures for the relief of ulcer of the duodenum and ulcer of the stomach. Is success to come, then, through a better knowledge of the involuntary nervous system? At the clinic we feel that the dangers from ulcers in the stomach require their removal sometimes by excision of the ulcer and sometimes by partial resection of the stomach, with enlarging of the pyloric outlet or the making of a new one to the intestine. It may be expected, however, that any operation which secures adequate drainage, whether it be at the pylorus or by a new outlet or some form of resection will relieve the patient of symptoms. A small percentage of persons suffering with such troubles, however, have secondary trouble of the same nature. I expect more trouble if the free acid is high. The essential, however, is loss of balance between the acids and alkalis, whether they are high or low, relative overacidity aiding in pyloric closure.

With pyloric spasms the food naturally has greater difficulty in passing, perhaps more waves have to break against the sphincter before they can force it, perhaps the degrees of acidity above and below the opening have less influence than normal, and perhaps, as a result, the whole mechanism of pyloric control breaks down. A Ramstedt division of the pyloric muscle may often be beneficial.

THE PERITONEUM AS RELATED TO PERITONITIS

AN EXPERIMENTAL STUDY

BY VERNON C DAVID, M D

AND

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OF CHICAGO, ILL

FROM RUSH MEDICAL COLLEGE

THE remarkable lowering in mortality in general peritonitis during the last twenty years has been largely due to early diagnosis, prompt, speedy, and non-traumatic operation, which aimed to eliminate the source of infection and to establish drainage where necessary, and to the institution of proper after-treatment, which includes Fowler's position, maintenance of fluid balance, stomach lavage and in certain instances ileostomy. While further progress along these lines will undoubtedly take place, it seems probable that a better understanding of the pathologic processes involved might lead to principles most important in the treatment of peritonitis. Many complex problems present themselves. In general they may be listed as to the absorptive powers of the peritoneum, the problem of development of paralytic ileus and its influence on mortality, and finally the questions involved in the early circulatory failure so frequently observed in general peritonitis. The questions raised are far reaching and not easy of solution. Some progress, however, may be made by the study of isolated problems which go to make up the whole.

Last year¹ the results of some experiments dealing with absorption of bacillus coli from the normal and inflamed peritoneum were presented, at which time a review of the literature on absorption of fluids and the passage of solid particles and microorganisms from the peritoneum was presented.

While it had been known for many years that microorganisms passed into the lymphatics from the normal peritoneum, where they entered the blood stream through the thoracic duct, it had been doubted that direct passage of microorganisms into the blood stream from the peritoneum was probable. By isolating and draining the left thoracic duct and at the same time ligating the subclavian, internal and external jugular and innominate veins on both sides of the dog's neck, we found that bacillus coli introduced into the normal peritoneum appeared in the chyle in from five to sixteen minutes, in the peripheral blood in from twelve to eighteen minutes, and in the liver and spleen at about the same time, though in less numbers. It was therefore practically certain that bacillus coli was taken directly into the blood stream from the normal peritoneum.

The next question studied concerned the passage of bacillus coli from inflamed peritoneum. Different grades of non-infectious peritonitis varying from a hyperæmia to a well developed plastic exudate could be established

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by intraperitoneal injection of turpentine emulsion. The passage of bacillus coli into the lymphatics and into the blood stream from the peritoneum was studied. It was found that in a well developed plastic peritonitis that the passage of bacillus coli into the lymphatics or into the blood stream was practically nil. Where the plastic exudate was absent or very slight, bacillus coli was taken up by the lymphatics and isolated from the chyle of the thoracic duct but no bacteria could be grown from the blood stream.

While all of the factors interfering with the passage of bacillus coli from the inflamed peritoneum may not be known, it can be fairly said that the presence of a plastic exudate in the peritoneum interferes very materially with the passage of bacillus coli into the chyle and seems to interfere entirely with the direct passage of these microorganisms into the blood stream.

The passage of bacillus coli from the peritoneum that contains a transudate was next studied. Hypertonic glucose injected into the peritoneum results in an increase in the volume of the fluid until it becomes isotonic. Starling² and his associates established the fact that the laws of osmosis govern the interchange of fluids in the peritoneum to the blood stream. We found that when bacillus coli was introduced into such an intraperitoneal transudate that the organisms appeared promptly and in large numbers in the chyle of the thoracic duct as well as in the peripheral blood stream. This point is of interest in connection with the rapidly fatal course of peritonitis developing in the presence of a transudate.

Working independently, Steinberg³ and his associates conducted experiments along these same lines and in all important points their conclusions and ours coincided.

The object of this communication is to present the results of some experiments dealing with the question of the absorption of toxins from the normal and inflamed peritoneum in animals.

While the laws of osmosis governing the absorption of fluid solution of known crystalline substances are well known, the problem becomes more complicated when we consider the passage through the peritoneum of complex protein toxins. The literature gives us little help in this particular question. Achard and Gaillard⁴ have shown that the higher the molecular weight of organic materials in the peritoneum, the lower will be the rate of absorption into the blood. Danielsen⁵ concluded that while crystalloids are absorbed from the peritoneum through the blood stream that colloid substances are absorbed through the lymph channels. Fleisher and Loeb⁶ performed nephrectomy or ligated the renal vessels and found an increased osmotic pressure of the blood and an increased rate of absorption from the peritoneum in those animals. They found no direct relation between diuresis and absorption from the peritoneal cavity. Pertinent to these observations, Starling points out that the osmotic pressure of blood proteins is related to the absorption of fluid by blood-vessels, in that by increasing protein concentration of a peritoneal saline solution, the absorbing force is reduced to the hydrostatic pres-

sure in the capillaries and absorption ceases Bolton⁷ concluded from his work that colloidal dyes indiffusible outside of the body pass through the peritoneum and capillary wall by diffusion directly into the blood, but slower than crystalloids Colloids of a large molecular weight pass through much slower and it is probable that albuminous molecules are unable to do so Klein⁸ states that toxins of low concentration are absorbed rapidly from the peritoneum and that conversely, toxins of high molecular weight are absorbed very slowly into the blood

Regardless of the above information, it is of course obvious that the very severe toxemia associated with general peritonitis must be caused in some degree by absorption of bacterial toxins from the peritoneum It was our object then to select a toxin, even though its chemical composition is not definitely known, which could be identified after its passage from the peritoneum into the chyle or into the blood stream Diphtheria toxin was selected because it could be obtained in large quantities and because of its known lethal properties when injected into guinea pigs

The object of our experiments was to determine the absorption of diphtheria toxin from the normal peritoneum, the inflamed peritoneum containing a plastic exudate, and the peritoneum containing a transudate in dogs Healthy adult dogs of medium size which had been fed on a fat diet were used

ABSORPTION OF DIPHTHERIA TOXINS FROM NORMAL PERITONEUM

The question to be determined was whether diphtheria toxin in the peritoneal cavity passed into the lymphatics of the peritoneum, directly into the blood stream or both

Experiment 1—The thoracic duct was exposed in the neck and divided The femoral artery was exposed and divided, the distal end having been ligated, the proximal end was closed with a vessel clamp so the blood could be obtained for culture Two to five cubic centimetres of chyle and 25 to 40 cc of blood were collected and injected subcutaneously into guinea pigs for control These animals lived Ten cc of diphtheria toxin (Parke Davis) was then injected intraperitoneally through a trocar inserted midway between the symphysis and ensiform Seventy-five cc of normal salt solution was also allowed to run into the peritoneal cavity to favor diffusion of the toxin

10 20	Toxin and 75 cc salt solution injected
	<u>Chyle injected subcutaneously into guinea pig</u>
10 30-11 10	25 cc injected
	Pig died three days later
11 10-11 40	75 cc injected
	Pig died three days later
	<u>Blood injected subcutaneously into guinea pig</u>
10 50	40 cc whole blood injected Pig lived
11 40	Dog bled to death 60 cc of blood serum injected into pig subcutaneously
	Pig died two days later

Seven experiments of this type with substantially the same results were performed In several the internal and external jugular, subclavian and innominate veins on each side were ligated to exclude the possibility of

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accessory chyle ducts emptying into the blood stream. In one experiment only 1 cc of toxin was injected into the dog's peritoneum, in which case all of the guinea pigs survived who received the dog's chyle and blood. In several animals the injection of 25 to 40 cc of whole blood taken during the experiment caused the guinea pig to die in two to three days.

These experiments demonstrate that a known toxin injected into a dog's normal peritoneum passes directly into the blood stream as well as into the lymphatics in sufficient quantities to be fatal to guinea pigs. The concentration of the toxin and chyle seems to be greatest in about thirty minutes after the intraperitoneal injection of the toxin.

PASSAGE OF DIPHTHERIA TOXIN FROM THE PERITONEUM

It was found that intraperitoneal injection of 5 cc of a 10 per cent turpentine emulsion on two successive days could cause a marked peritonitis with marked fibrin deposits and a serosanguineous fluid exudate. The passage of diphtheria toxin from such an inflamed peritoneum was studied in four dogs.

Experiment 2—Forty-eight and twenty-four hours before the experiment 5 cc of a 10 per cent turpentine emulsion were injected by hypodermic into the peritoneal cavity. On the morning of the experiment the thoracic duct and femoral artery were exposed as in Experiment 1. Control blood and chyle injected subcutaneously into guinea pigs did not affect them.

10 15	10 cc of diphtheria toxin and 50 cc of salt solution injected intraperitoneally through a trocar
	<u>Chyle collected and injected subcutaneously in a guinea pig</u>
10 20-10 50	6 cc of chyle injected Pig lived
10 50-11 15	10 cc of chyle injected Pig lived
	<u>Whole blood injected subcutaneously in a guinea pig</u>
11 10	25 cc injected Pig died eight days later
11 20	Dog bled to death 20 cc of blood serum injected subcutaneously into guinea pig Pig lived

An autopsy performed on the dog after the experiment showed a fibrino-serosanguineous exudate involving the whole peritoneum.

The results in all these experiments were substantially the same. It was somewhat more difficult to collect chyle as it was always found that chyle flowed very sparsely where a marked plastic peritonitis was present and instead of being milky the chyle was colorless and thin. None of the pigs receiving chyle died, whereas two pigs receiving whole blood died, one on the eighth day and one on the twelfth day.

We may conclude from these experiments that in a well developed plastic peritonitis caused by the injection of turpentine from the peritoneum of dogs, that the passage of diphtheria toxin into the peritoneum into the chyle is practically nil, that it passes into the blood stream in much smaller quantities than from the normal peritoneum. Indeed it may be questioned whether the pigs dying in eight and twelve days after the experiment really died from the effects of the toxin.

PASSAGE OF DIPHTHERIA TOXIN FROM THE PERITONEUM
CONTAINING A TRANSUDATE

As is well known, the injection of hypertonic solutions into the peritoneum attracts fluid into the peritoneum. Several writers have advised the use of hypertonic solutions intraperitoneally in the treatment of peritonitis. The object of this experiment was to determine whether the injection of hypertonic glucose solution into the dog's peritoneum would influence the passage of toxin from the peritoneal cavity.

Experiment 3—The day before the experiment 25 c.c. of a 50 per cent glucose solution was injected intraperitoneally in medium size dog. The other factors in the experiment were arranged as in Experiments 1 and 2.

10 20 5 c.c. of controlled chyle injected subcutaneously into guinea pig. Pig lived
 10 c.c. of diphtheria toxin and 50 c.c. of salt solution injected intraperitoneally

Chyle injected subcutaneously into guinea pig

10 20-10 29 5 c.c. of chyle injected Pig died
10 30-10 40 6 c.c. of chyle injected Pig died
10 40-10 50 7 c.c. of chyle injected Pig died
10 55-11 05 6 c.c. of chyle injected Pig died

Blood injected subcutaneously into guinea pig

10 55 25 c.c. of whole blood injected Pig died
11 10 Dog bled to death 20 c.c. of blood serum injected into guinea pig
 Pig died
 30 c.c. of blood serum injected into guinea pig Pig lived

At autopsy of the dog several hundred cubic centimetres of fluid were found.

This experiment demonstrates that the presence of a transudate in the peritoneum does not hinder the passage of the diphtheria toxin into the blood directly or by the lymphatics but rather favors the absorption by these routes. This fact is of interest in connection with the rapidly fatal course of peritonitis occurring in patients with ascites.

CONCLUSIONS

1 Diphtheria toxin passes promptly in considerable amounts directly into the blood stream as well as to the peritoneal lymphatics from the normal peritoneum of the dog.

2 Intraperitoneal transudate favors the prompt passage of diphtheria toxin from the peritoneum.

3 A plastic peritonitis markedly if not completely interferes with the passage of diphtheria toxin from the dog's peritoneum.

4 By analogy we may assume as a result of these experiments that when a plastic exudate is formed in the peritoneum, the passage of bacteria and toxin from the peritoneum is markedly interfered with. It would seem therefore advisable in the treatment of peritonitis to interfere as little as possible with the plastic exudate that is formed, as it can be regarded as a

THE PERITONEUM AS RELATED TO PERITONITIS

favorable process. Perhaps it is unwise to press the analogy between dog and human peritoneum further, but one would feel from these experiments that in the early hours of peritonitis the factors of absorption of toxins and bacteria into the circulation directly and via the lymphatics was the dominant factor of danger, while later absorption from the peritoneum became less important and local conditions, such as paralytic ileus gained the ascendancy in the picture.

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CHRONIC APPENDICITIS

BY REA SMITH, M D

OF LOS ANGELES, CALIF

AT VARIOUS times during the last ten or fifteen years, we have all heard the last word spoken on "appendicitis" and it seems almost a waste of time to re-open the subject that has been so much and so thoroughly discussed. However, in studying the physiology and pathology of the ileocaecal coil from another standpoint, the so-called "chronic appendix" has forced itself into the picture so often that I am persuaded to present my observations to you with the hope that the 50 per cent unrelieved by appendectomy may be benefited. We believe that in the disease known as "chronic appendicitis" the appendix may be implicated, but often is a small part of the condition and that the removal of the appendix alone very frequently fails to relieve the symptoms for which the patient presents himself for operation. Failure to effect a cure has been so common that there is a growing tendency in the profession to charge the "chronic appendix" symptom syndrome to neurasthenia and to discourage surgery. This we think is as great a mistake as the simple appendectomy. We are sure that correlation of the embryological, physiological, and pathological factors will lead us nearer to the etiology and therefore the logical treatment.

"Harvey¹ makes four main subdivisions in the journey which the caecum makes from its inception to its final lodgement in the right iliac fossa, namely *Migration rotation descent*, and *fixation*. In the fifth week of fetal life, the primitive gut is attached to the umbilicus and the caecum is beginning to show as a bud on the caudal portion of the gut. As the liver at this stage rapidly increases in size, the bowel is pushed out of the coelum into the umbilicus. Next the relative increase in size of the body cavity permits the return of the gut. The small intestine is the first to return and the large bowel follows. The junction of the small bowel with the large is forced by the small intestine into the upper right quadrant and at this stage the small intestine enters the large from the right and above. This ends the migration. The next stage is that of *rotation*, resulting in the entrance of the small bowel on the inner side, or from the left and below. *Descent* starts at this point and in the latter months of fetal life and first month after birth the growth of the organ carries it and the ileocaecal valve into the lower right quadrant. Fusion of the various mesenteries results in the position which is termed normal in the adult life. It is well to note that the descent and fusion are relatively late stages in the developmental cycle. Studies in comparative anatomy would indicate that fusion is doubtless a result of the assumption of the erect posture of mankind, and it is just to suppose that on the success of these last two

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processes, will depend to a considerable extent the ability of the bowel to function properly"

The external longitudinal muscle fibres of the colon are gathered into three distinct longitudinal muscular bands, which lift the cæcum many inches in a so-called normal ascending colon, pulling from the first fixed point the hepatic flexure, and are largely concerned in the normal mechanism of emptying the cæcum

The intestinal wall carries within *itself* the mechanism essential to peristalsis. The law of peristalsis of Bayliss and Starling was worked out experimentally on the dog,

with a balloon in the *small* intestine attached to a manometer. It was demonstrated that pinching the intestine just above the balloon, caused a cessation of peristaltic activity and a dilatation of the intestine from eight to twelve inches below the pressure, that pinching of the intestine behind the balloon caused

a spasticity and great increase in peristalsis ahead of the pressure. Our observation reverses this process in the colon. In other words, pressure upon a ganglion contained in the wall of the colon causes dilatation behind and spasticity in the front. This is our conception of the production of the thin-walled, blue, atonic cæcum. With a mobile cæcum and ascending colon, due to



FIG 2—The same change of position of the cecum supine and standing except that in this case there is no pericolic membrane, the cecum descended retains its haustrations and crurae no symptoms

faulty fusion, the terminal event in the embryologic cycle, we have the ideal condition for the development of a long chain of events. Beginning with loss of tone, due either to advancing years, a long strain or a long physical illness, we have a loss of the lumbar curve, which is the shelf on which the normal cæcum lies. With the loss of the lumbar shelf we have a tendency of the cæcum to prolapse. Nature in her effort to lift up a prolapsing organ starts the growth of a membrane at the site of the right colic artery on the



FIG 1—Showing haustrated cecum in normal position with patient supine. Completely rotated unhaustrated cecum descended into the pelvis with patient standing

mesenteric side, which attaches the colon tightly to the side wall by a reduplication of the peritoneum. This was first described by Jackson many years ago and is generally known as "Jackson's Membrane." As this attachment becomes tighter, the colon is rolled to the right and twisted, the prolapsing heavy cæcum



FIG 3—Cecum turns inward and fixed by adherent appendix causes obstruction at site of pericolic membrane when the cecum descends when the patient is erect

swings forward and to the left exaggerating the twist. This twist so pinches the intestinal wall containing Auerbach's plexus that caecal dilatation with lack of peristalsis follows, and a spastic colon *forwards* from the point of pressure develops. This paralysis of the cæcal muscular walls due as we think to plexus pressure is at first intermittent, occurring when the

patient is erect and disappearing when prone, making it easy to miss, either in routine X-ray examination or on the operating table.

We feel that here we have the formation of a vicious circle. As the cæcum becomes heavier the strain increases at its point of fixation, a pericolic

inflammation due to strain tightens the band, so that eventually the obstruction may become anatomical as well as physiological. There is often a retrocæcal appendix, in many cases an undescended appendix, which draws the cæcum sharply up to the right, so that that part of the intestine which appears to be cæcum in the X-ray study is really the



FIG 4—Cecum fixed and turned inward by an adherent appendix when patient is erect but retaining its haustrations when it descends as there is no pericolic membrane

middle of the ascending colon. This, the retrocæcal appendix, is usually included in the adventitious attachments of the ascending colon.

Actual mechanical fixation of any part of the cæcum or ascending colon interferes with the direct pull of the longitudinal bands from the normal fixed point at the hepatic flexure, and so prevents the lifting of the cæcum.

This theory is based largely on deductions from clinical observation at the operating table and in the X-ray laboratory. We have demonstrated so many times that it is no longer a cause for remark, that this toneless cæcum,

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unhausted, dilated, and thin-walled, appearing to have no muscle, is capable of an *immediate* return in color, thickness and peristaltic activity. This *immediate* return of peristalsis upon removal of the plexus pressure must disprove the theory of Lane that the cæcum has become toneless through atrophy of muscle from *hydrostatic* pressure, and the theory that the muscle has atrophied through trophic changes from long toxemia. Also this disproves the theory of ordinary anatomical intestinal obstruction in the ascending colon. For in all parts of the intestinal tract a simple partial anatomical obstruction gives rise to increased peristaltic activity and hypertrophy behind rather than atony and dilatation.

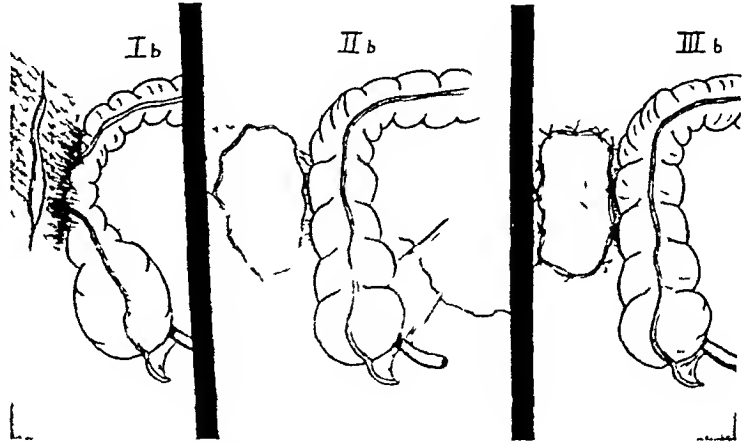


FIG 5—I Showing pericolic membrane incised at its junction with the parietal peritoneum II Colon rolled out III Denuded surface covered with free omental graft

With the colon pulled tightly to the left, the assistant holding the flexure in one hand and the cæcum in the other, the reduplicated peritoneum is divided with a sharp knife at the white line, which marks its junction with the

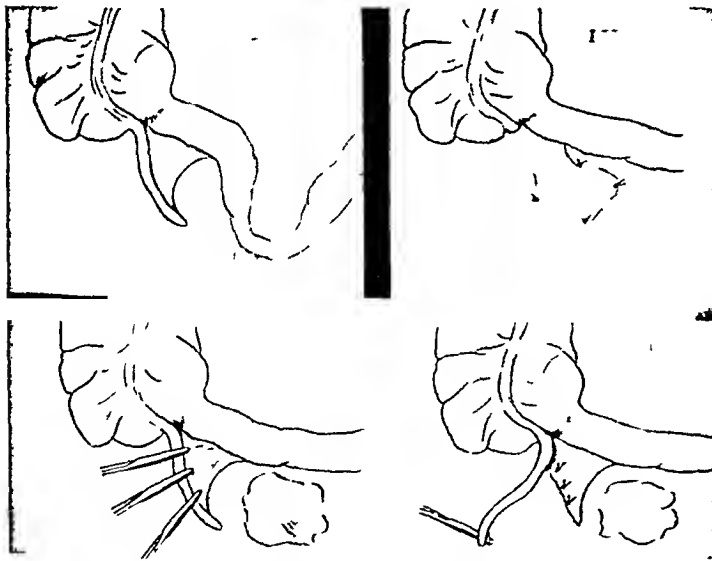


FIG 6—Method of utilizing spread out meso appendix to cover denuded area on mesentery after division of Lane Kink

parietal peritoneum, the ascending colon immediately becomes straight. The edges of the longitudinal incision in the peritoneum are separated four or five inches by the rolling out of the colon which has been compressed over the right kidney. The cæcum immediately draws up, regains its pink color and contracts when pinched between the gloved finger and thumb.

We plant in this denuded

area a free omental graft, carefully stitching the omental edge to the edge of the peritoneal incision. Interposition of tissue apparently prevents reformation of the constricting membrane as we have never re-operated one for adhesions in a series of more than two hundred cases scattered over a period of ten years.

These typical cases with the mid portion of the ascending colon rolled to

the right and attached to the parietal peritoneum, would seem ideal for cæcal fixation to prevent descent and twist

We have been unable to find a method of fixation which may not defeat its own object by interfering with peristaltic waves which are necessary for the emptying of the cæcum, and prefer to reproduce the mobile cæcum and depend upon external support to prevent the band from reforming

Our experience has taught us that the prolapsed cæcum is comparable to the prolapsed stomach—it will empty from any position if the whole organ prolapses and if peristalsis is not interfered with by some other cause than position

We have become convinced that the symptom syndrome, usually called “chronic appendix”, is almost always due to interference with cæcal peristalsis, rather than appendicial inflammation. In fact we feel that without a history of sharp attacks accompanied by fever and vomiting, a diagnosis of chronic appendicitis can not be made. The reflex stomach symptoms are caused in our opinion by recurring temporary intestinal obstructions, partial or complete, due to the twisting of a loaded cæcum over a fixed point. And only those cases in which the undescended appendix is retrocæcal, and its delivery releases the colon fixation or in which the appendix alone cripples the cæcum, is there symptomatic cure, following a simple appendectomy

This condition is easily demonstrated by gastro-intestinal study by the method of Taylor.² He routinely examines the ileocecal coil for mobility as well as motility. He makes observations at six, nine, twenty-four, and forty-eight hours—both erect and supine. He finds as I will show you with slides that there is a change of location of the loaded cæcum of from six to eight inches with a change of position of the patient, that a perfectly normal appearing colon with the patient supine will drop to the bottom of the pelvis when observed standing. And he is convinced that a barium enema is entirely worthless as a means of diagnosis of most right-sided conditions. The first sign is a distinct break in the barium column in the ascending colon with a mass movement of the barium forward from the point of break, leaving an unhausted packed cæcum

Clinical Analysis—Taking for analysis 571 consecutive cases diagnosed “appendicitis” on which I have operated

One hundred were acute, 51 were sub-acute—these can be disregarded

Of the remaining 420 cases, diagnosed “*chronic* appendicitis”

Seventy-two only had a history of a previous sharp attack

One hundred and sixty-five had pyloric spasm described as stomach symptoms

Of these, 8 had duodenal ulcer

And 38 a diseased gall-bladder discovered at operation and operated upon at the same time or subsequently

All had constipation varying in degree

Seven had history of colitis with occasional attacks of diarrhoea

All had a spastic colon as demonstrated by the roentgenologist

CHRONIC APPENDICITIS

The appendix only was removed in 202 cases just less than 50 per cent. One hundred and eighty-six had a distinct pericolic membrane, crippling the cæcal peristalsis and causing a cæcal block.

Of these, thirty-two had had a previous appendectomy without symptom relief.

Fifty-eight had the terminal ileum bound down as described by Lane and termed "Lane Kink."

Fourteen had had a previous appendectomy without symptom relief.

Seventy-six cases were found at operation to have retrocæcal appendix.

In 34 of these the appendix alone was removed, the crippled cæcum being released by its removal.

In 35, a binding down of the mid-portion of the ascending colon by a pericolic membrane was dealt with separately.

In 3, an appendix and upper abdominal lesion were found.

And in 4, the appendix, pericolic membrane and upper abdominal lesions were present.

We feel that in this series of 420 cases of chronic appendicitis, only 202 had a right to relief of symptoms if the appendix alone had been removed, that in the remaining 218 cases it was necessary to deal with the other pathology encountered in order to expect a symptomatic cure. My especial interest is in the group of 186 cases complicated by the pericolic membrane which I think is usually not recognized and not disturbed at operation. I feel that this condition associated with the pathological appendix must be dealt with just as definitely as gall-stones or ulcer in order to relieve the patient.

Closing Discussion—Dr. Rea E. Smith (Los Angeles, California). Doctor Jones asked as to the end results of the 220 cases. I am embarrassed to answer that question. I left out end results because my follow-up is not perfect. I was unable to find any patient in this series in whom the symptoms persisted after operation. But I am sure that must be due to the fact that I could not hear from them all. However, our office is free from the chronic unrelieved patients that we had in the old days when we did appendectomy alone for chronic appendicitis.

In conclusion we believe that the symptoms that we are accustomed to call "chronic appendix" have a larger pathology than appendicial inflammation, that simple appendectomy will cure less than fifty per cent of these cases, that these symptoms are caused by a distinct surgical disease and are not to be laid to the door of neurasthenia, and that symptomatic relief may be obtained surgically in the same high proportion of cases as is obtained by surgery upon the diseases of the gall-bladder, the stomach, and the duodenum.

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DISCUSSION DR CHARLES L GIBSON New York City, said that the most astonishing thing in their original follow-up of six years was the shocking discovery of their very bad results in chronic appendicitis—if he remembered correctly, 30 per cent. This led them to investigate why they were getting such bad results. Practically they had no bad results in operations for acute appendicitis, that is, the patients coming back after operation for acute appendicitis are practically immune from any complaints, and yet here are the other class who come back full of complaints.

They have reduced bad results largely by operating on conditions under their right name, that is, they study their cases very much more thoroughly, and particularly in the diagnosis of chronic appendicitis in women. As a matter of fact, very often they operate on so-called chronic appendicitis as a prophylaxis against acute appendicitis. Certainly in his hospital service he has four times as many operations for acute appendicitis in men as in women, and yet it is these unfortunate women who get operated on for chronic appendicitis.

When a patient comes in with symptoms seemingly pointing to chronic appendicitis, they try to get away from that diagnosis as far as possible and try to exhaust every other possibility. One of the elements is a thorough history. The service is handicapped by so many foreigners, ignorant recent immigrants, a very distinct handicap. Some of the bad results have been particularly in those cases where they had been unable to get a full history. These patients nowadays are thoroughly studied, and studied especially fluoroscopically.

A second way in which they had improved their results has been by doing a surgical operation. He did not call taking the appendix out through a tiny hole a surgical operation. Some of their earlier results he thought might be attributed to that. The appendix was simply pulled out and removed without any exploration. Every operation for chronic appendicitis should be an exploratory laparotomy, removing not only the appendix but investigating the rest of the abdomen and remedying the conditions present. Many conditions can be remedied, especially in women, very often diseased pelvic organs that could not be recognized short of a laparotomy.

BEZOARS

WITH THE REPORT OF AN ADDITIONAL CASE OF PHYTOBEZOAR

BY URBAN MAES, M D

OF NEW ORLEANS, LA

A SINGLE case report as the *raison d'être* of a clinical paper is rather deserving of an apology and certainly deserving of an explanation. In this instance, however, I believe that my reason is fairly obvious, the desire to call attention to a condition which is almost entirely ignored by text-books and systems of medicine and which, although rare, is a possibility always to be considered in the diagnosis of obscure gastric conditions.

Bezoars are by no means as rare as they were formerly supposed to be. From 1779, when the first case (a trichobezoar or hair ball) was reported by Baudamant in the *Journal de Médecin*, until 1914, when Matas' classical paper was read, only seventy-six cases had been reported in the literature. In 1921 Davies reported thirty-two additional cases, and since then others have been reported by Barkeley, Carr, Doohn, Harris, Herzfeld, Neely, Netto and Whittman, making in all one hundred sixteen cases. Hart, in 1923, added eight cases of phytobezoar to the five already reported, and since then, in addition to the case I am now reporting, others have been added by Hamdi (three), Porter and McKinney (two), Tschassownikoff, Larimore (two) and Upson, bringing the number of this type to twenty-three.

It is quite probable, as Matas suggests, that the total would be materially increased if a canvass could be made among surgeons generally and if the many unreported cases which undoubtedly have occurred were thus brought to light. It is even more probable that many cases exist undetected, especially in rural communities, where X-ray facilities, which offer the only sure method of diagnosis, are generally lacking. Simon, in a discussion of Hart's paper, called attention to the fact that such foreign bodies may be the real explanation of many supposedly inoperable gastric carcinomata which have been diagnosed only clinically, and suggested also that they might explain many fatal instances of perforation supposedly due to ulcers. The latter supposition is especially valid in view of the fact that Butterworth's case, as well as several others reported, was of this sort, the diagnosis being made only at autopsy.

The term bezoar is generally applied to concretions found in the stomach and intestines of animals, and the reader who is interested in the historical and archeological aspects of the subject is referred to the report of Matas already quoted which was read before the Southern Surgical Association in 1914. Hair balls or trichobezoars are particularly common in the cow, the horse and the cat, especially during the hair-shedding seasons. Often they

are vomited or are passed per rectum, but even if they are retained they are apparently without harmful effects. This type of bezoar is the one most commonly found in humans, and the majority of the reported cases are in young girls of the English-speaking races. To date only two cases have been reported in males, in the first instance the man was found to be chewing his beard, in the second the man was insane and when the tumor was removed surgically it was found that hair played only a minor part, nails, wire and other such objects making up its bulk.

Formerly the common explanation of these tumors was the obvious one, that young girls with long flowing hair were prone to play with it and might end by swallowing bits of it, but with the advent of universally bobbed heads such an explanation is no longer tenable, and it will be interesting to observe whether the incidence of trichobezoars will be lessened in this generation. Some psychic or neurologic factor is unquestionably at work in such cases as that reported by Neely, for instance, in which a patient from whom a trichobezoar had been removed surgically began to eat her

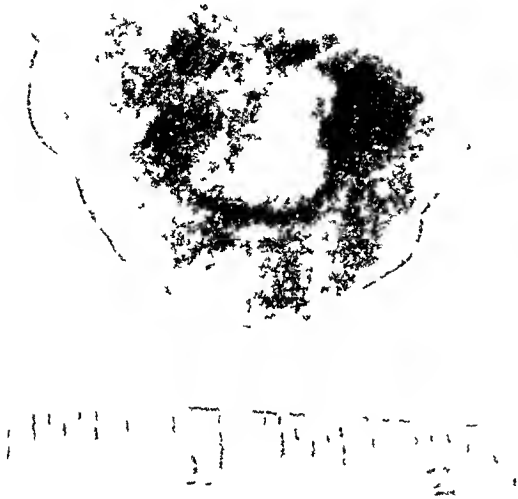


FIG. 1.—Photograph of tumor

hair again before her discharge from the hospital. Even more remarkable in this regard is the case reported by Harris, in which within fourteen years five operations were performed on the same patient for the removal of such masses, in the last operation the tumor was found extending into the duodenum and weighing two and a half pounds. As a rule, however, when the psychic factor is apparent the tumor contains string, cotton and other materials manifesting a truly perverted appetite.

Trichobezoars, unlike phytobezoars, are constantly added to as additional hair is swallowed, and they may attain considerable size, the one reported by Davies, the largest on record, weighing six and a half pounds. They may extend into the duodenum and detached masses may be found in the ileum. Digestion is generally good until the mass completely fills the stomach, probably because the bulk of the food taken is normally subject to extra-gastric digestion, and the tumor, being compact, does not absorb it in its passage through the stomach. Ultimately there is pain, vomiting, constipation alternating with diarrhoea, foul breath, anemia and exhaustion. A rather remarkable and quite uniform finding in most of the reported cases is that, until the last stages, the patient's nutrition and vigor are only slightly

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impaired. Death finally occurs from inanition, intestinal obstruction or perforation.

Phytobezoars, or fruit and vegetable tumors are composed chiefly of persimmon, prune or raisin seeds and skins or of celery and salsify fibres together with starch granules, fat globules, muscle fibres, elastic tissue, fatty acid crystals and epithelial cells. The etiology is obscure and such explanations as have been advanced are entirely speculative. Both hypoacidity and hyperacidity have been suggested as causes, but the gastric analyses in the reported cases are still too few and their variations from the normal are too slight to warrant drawing any conclusions from them. Another explanation is that the high percentage of gum and of pectin (14.1 per cent and 7 per cent respectively) in persimmons favors cohesion, while the muscular action of the stomach, initiated by the ingestion

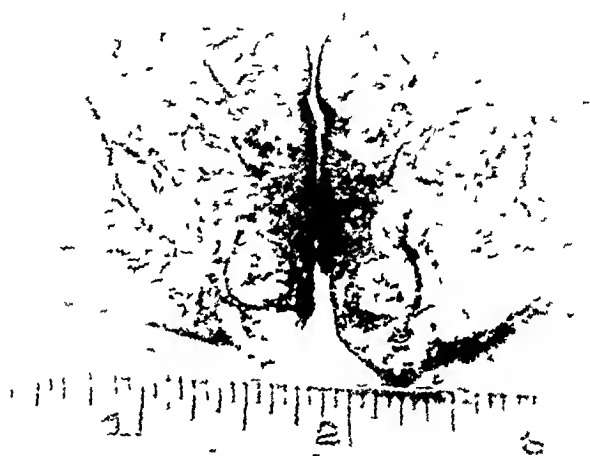


FIG. 2.—Photograph of tumor on section showing of persimmon seeds and hulls.

of food, easily molds and compresses the already coherent mass, the excessive muscular activity induced by the consequent acute gastritis then completes the process, so that the tumor remains intact even after the cohesive substances have been removed by the normal digestive mechanism. Granting the correctness of this assumption it is still not clear why the condition should occur only in certain individuals, who must comprise surely a negligible number of those who consume these very common foodstuffs.

The symptom complex is always that of an acute gastric disturbance, with pain which tends to be paroxysmal in character the chief feature. In most of the reported cases the pain tended to persist, though to a minor degree, between attacks, and it was both increased and decreased by eating. In some instances it was little more than a sense of fulness in the epigastrium. Vomiting is not usually marked. When it does occur, it is mucous or watery, because the bezoar acts as a ball-valve in the cardiac opening and prevents the full ejection of the stomach contents. The acute pain on the other hand is due to a similar obstruction at the pyloric opening which results in the retention of the food within the stomach. As is the case with trichobezoars the most striking feature of the syndrome is that in spite of the persistence and the severity of the symptoms the patient's general health remains good, there is rarely great loss of weight and the nutrition is prone to remain unaffected.



FIG 3—Radiogram of stomach showing filling defect

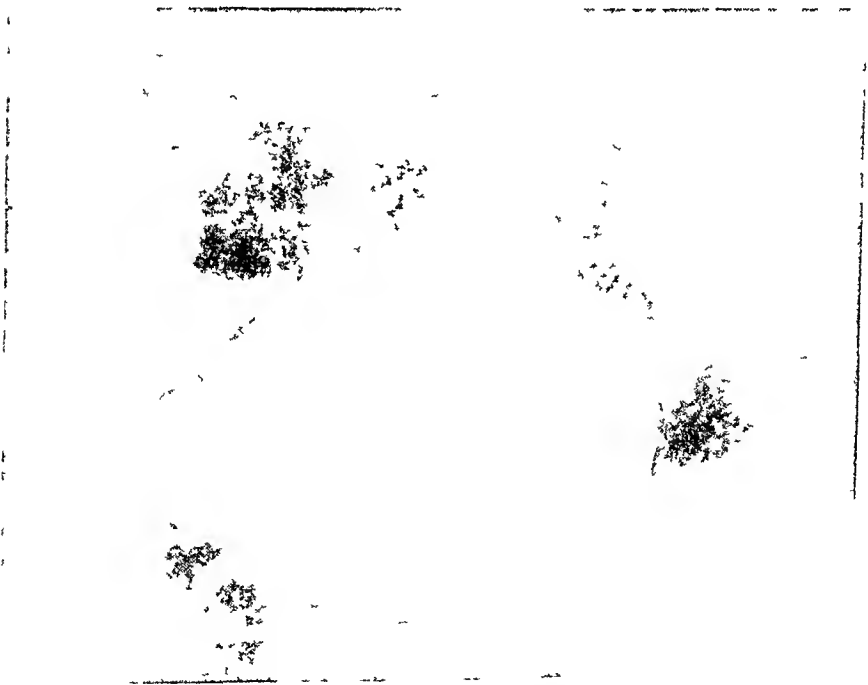


FIG 4—Same, with filling defect being displaced by external pressure

BEZOARS

Two other types of bezoar are classified by Hart, the trichophytobezoar, a combination of the two varieties we have just described, and the shellac concretions, often of large size, found in painters and furniture workers who have swallowed the shellac solution used in their work, presumably for the sake of its alcoholic content

Until the advent of the X-ray the pre-operative diagnosis of bezoars was seldom made correctly, though now, with the proper employment of this facility, it is almost impossible to miss it. The history is not helpful unless a story of hair-eating or of the ingestion of certain types of food is definitely elicited, and this does not usually happen unless the possibility is borne in mind and the patient is specifically questioned on these points. The presence of the palpable mass suggests malignancy, though the acuteness and duration of the symptoms and the generally good condition of the patient are against this. It is always possible, of course, that other pathology may exist and



FIG 5—Same tumor pushed up into cardia and therefore not visible

may cloud the issue, as in Larimore's case, in which the phytobezoar was entirely overlooked because a previous cholecystectomy with subsequent pyloric and duodenal adhesions had destroyed the mobility of the tumor and confused even the X-ray findings

As a rule, however, the radiographic findings are constant and definite. The mass lies free in the gastric cavity, where it is seen as a shadow or as a lighter area amid the darker area of the barium which outlines and coats it. Under the fluoroscope it can be made to change its position freely on palpation. Later examination discloses a normally empty stomach except for the barium-streaked, freely movable tumor. Barium must always be administered, for simple anterior-posterior examination does not give constant findings. The efficacy of the X-ray as a diagnostic agent is the undoubted explanation of the increasing number of cases of bezoar reported

within the last decade, it would be unreasonable to suppose that their incidence is increasing.

The treatment is essentially surgical. Massage has been advised but it is obviously unreliable, quite aside from the fact that the possibilities of danger inherent in such a method do not warrant its serious consideration. Likewise digestants do not commend themselves, for it would seem that any agent strong enough to affect the tumor is likely first to injure or even to destroy the more delicate gastric mucosa. In fairness, however, the case of Mills and Simpson, quoted by Hart, must be mentioned, in which a phytobezoar was dissolved by dilute hydrochloric acid, the diagnosis being confirmed both before and after treatment by X-ray examination.

Surgery, therefore, is the preferred treatment, with the technic in the main that of the usual gastrointestinal operation. The incision should preferably be along the anterior wall of the stomach, where the vascularity of the tissues is least, and should be sufficiently large to permit the easy removal of the tumor. Drainage is seldom indicated, though naturally every precaution should be taken to protect the peritoneal cavity from the spill of the stagnant and often decomposing gastric contents. Careful exploration beyond the stomach is always indicated, and enterotomy should be done if additional masses are found in the small bowel. I have made no effort to figure the operative mortality in the cases reported since Matas' paper was written, but from casual observation I would say that it cannot exceed the 4 per cent. stated by him for the forty-seven operative cases reported to that date.

CASE REPORT—A G, a fifty-seven-year-old white merchant, from one of the rural communities of Louisiana, was seen by me in June, 1927, at which time he complained of abdominal pain which had persisted for two and a half years. The first attack had been ushered in with acute, cramping abdominal pain, so extreme that relief was finally obtained only after the administration of morphia several hours later. There had been no nausea or vomiting. Since that time similar attacks had occurred at intervals of from one to three weeks, always with pain the dominant feature, at times the ingestion of food or even of a hot drink gave relief, but usually morphia was required. In the interval he was perfectly well except for some shortness of breath, most evident after meals and without relation to physical exertion. The general health was good and there had been no marked loss of weight.

Physical examination disclosed a small, freely movable mass in the upper abdomen but otherwise was entirely negative. The condition, largely due to the character of the pain, had previously been variously diagnosed as acute gastritis, gall stone colic and angina pectoris, but in my opinion the presence of the mass rather suggested malignancy, particularly in view of the patient's age, though I was obliged to grant that its apparent free mobility, the acuteness and duration of the symptoms and the excellence of the patient's general health were all against this supposition. It was not until X-ray examination was done that the true condition was revealed, and it is entirely due to the discernment of Dr. W. F. Henderson, radiologist at Touro Infirmary, that the correct pre-operative diagnosis of phytobezoar was made. The findings are so typical of all such cases that the report is appended in full.

"At the entrance of the first bolus of barium into the stomach it is observed to strike upon a large oval mass and to pour downward from it, and each succeeding swallow of

BEZOARS

barium manifests the same phenomenon. As the barium is ingested, the stomach fills around this globular mass, leaving a punched-out area in the median portion. Manipulation with the gloved hand causes this to pass very freely down to the pylorus, and subsequently it can be forced into the extreme fundus of the stomach, where it remains for a time, only to pass again into the median segment. The mass changes its position with changes in the posture of the patient, and no incisura or niches in the gastric walls can be observed. It is believed that were a pedunculated tumor present, traction upon the pedicle would compel distortion of the gastric wall. It is therefore considered that this mass is free in the stomach and is most probably a phytobezoar. The duodenal bulb is free from pathology, as is the remainder of the gastrointestinal tract. It is interesting to note that specific questioning of the patient reveals the fact that persimmons were eaten on the day from which he dates his illness."

The patient later added further details of the onset of his illness. While hunting he had thrown himself under a persimmon tree to rest and had gorged himself with the ripe fruit lying beneath it, afterward drinking copiously of spring water. The attack, as previously described, had ensued almost immediately.

The further history is without special incident. Laparotomy through a left rectus incision exposed the stomach and permitted the palpation of the floating intragastric mass, which was removed without difficulty through a typical gastrotomy opening in the anterior wall. The patient's recovery was uncomplicated and his cure has been complete.

The mass removed had a very foul odor. It was dark brown, hard and roughly spherical, and exhibited a sort of mosaic appearance due to its composition of persimmon skins and seeds held together by some cellular material of undetermined origin. It weighed 386 grams and measured roughly two by three inches. The presence of the fruit on the surface showed that the mass had formed promptly after the ingestion of the persimmons and that no other material had since been added to it.

Every feature of this case is typical, and had the possibility been borne in mind and the patient specifically questioned, the diagnosis could probably have been made, at least tentatively, even before X-ray examination was done.

SUMMARY

1. A case of phytobezoar is reported, with the idea that the condition, though admittedly rare, is being overlooked as a possible cause of obscure gastric disease.

2. Trichobezoars (hair balls), phytobezoars (skin and seed balls), trichophytobezoars (a combination of these two) and shellac concretions are possible types of bezoar.

3. These all give rise to varying degrees of gastric distress. Pain is usually a marked feature and the general nutrition is surprisingly little affected.

4. The X-ray offers the only definite means of diagnosis and its aid should be invoked in all instances of obscure gastric disturbance.

5. Surgery is the only safe and effective treatment.

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NOTE. This bibliography supplements the one attached to Matas' article "Hair balls or hair casts of the stomach and gastrointestinal tract", which appeared in *Surgery, Gynecology and Obstetrics*, November, 1915, vol. xviii, pp. 594-608. I am indebted to Miss Mary Louise Marshall, assistant librarian of the Orleans Parish Medical Society, for its preparation.

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DISCUSSION DR VERNON C DAVID, Chicago Ill, remarked that these persimmon balls may perhaps be more common in certain regions of the country than is generally appreciated. He had seen one which was about half the size of an ordinary building brick, which was removed from the stomach. He reported that case to the Western Surgical last year, and in the discussion there must have been at least fifteen or twenty members of the Society who had seen cases of that kind although the literature does not report very many of them. He felt that the further publicity of such facts may be useful in early diagnosis and proper understanding of the situation.

DR EMMET RIXFORD, San Francisco, Calif, recalled that the Chinese utilized the principle of "similia similibus curantur" long before Hahnemann. In fact, it goes back well beyond the Christian era. One of their remedies was to use bezoar stones which were found in animals as a sovereign remedy against cramps.

ADAMANTINOMA

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From time to time articles on adamantinoma (adamantine-epithelioma, cystosarcoma, adeno-carcinoma, epithelial odontoma, etc.), appear in the literature, and from the few cases reported it would appear that the tumor is comparatively rare. As a matter of fact, it is apparently not uncommon,

but is often confused with bone cysts, benign giant-cell tumor, or carcinoma.

Most of the published articles are reports of two or three cases with a discussion of the origin and formation of the tumors. For a review of the pathology and a complete bibliography, the reader is referred to recent articles by Bump¹ and Murphy².

The present communication is based on twelve cases seen at the Collis P. Huntington Memorial and the Massachusetts General Hospitals.

All of these cases have been seen or operated upon by the author. Two

other cases in which the clinical diagnosis of adamantinoma was made were observed, but pathological material was not available and they have been excluded. Microscopic sections from nine of the twelve cases reported were available for review, while reports from competent pathologists were obtained in the remaining three.

To understand these tumors and recognize the different types, a clear knowledge of their formation is necessary. The tumors arise in the jaws, the lower more often than the upper, from the remains of the enamel organ, or from the paradental epithelial debris. Similar tumors of congenital origin are occasionally seen in the region of the hypophysis (Peet³). In the formation of the tooth, all parts are of mesoblastic origin with the exception of



FIG. 1.—Case 11, male, sixty-two years of age. Tumor of one year duration. X-ray shows cystic tumor in the ramus of the lower jaw near the angle. The typical appearance has been somewhat masked by secondary inflammatory changes. Death nine months later from local extension of tumor and sepsis. (See Fig. 2.)

the enamel. This is derived from an infolding of the epithelium covering the gum, the formation of the enamel organ being analogous to that of a gland. The connective tissue surrounding this ingrowth proliferates forming the dental bulb on which the enamel rests. These tumors arise from the cells of the enamel organ or the epithelial rests in the immediate vicinity, also derived from the infolding of the buccal epithelium. The epithelial cells differentiate to a greater or less degree and the tumors, therefore, vary in their appearance. If the epithelial cells are only slightly differentiated and

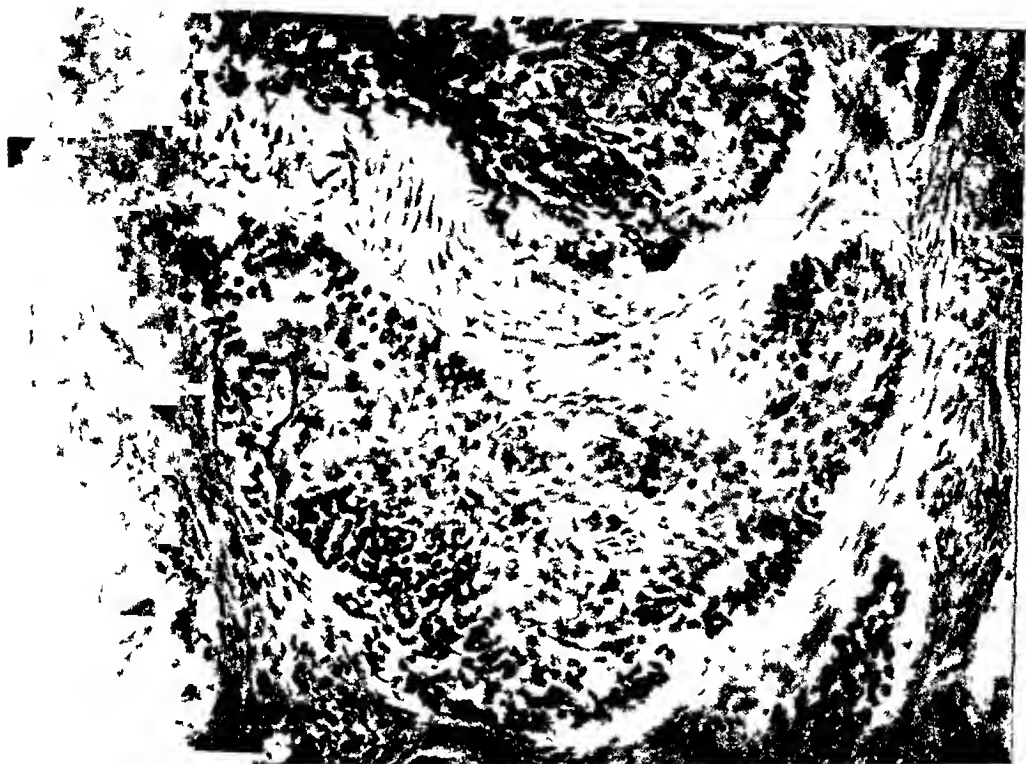


FIG 2—Photomicrograph of Case 11 (See Fig 1) The epithelial cells show little differentiation and the appearance of the section closely resembles cancer. Columnar cells are seen, and in other sections from the same tumor, enameloblasts could be found.

in solid masses, the general appearance microscopically is that of carcinoma. In certain instances the cells have a glandular arrangement and may resemble the malignant adenoma of the salivary glands. If differentiation of the original epithelial cell to the enamel cell has progressed farther, the cells are cylindrical and star-shaped cells or true enameloblasts are seen.

Although in a given tumor all the cells may be of one type, it is usual to find cells presenting all degrees of differentiation. There is also a certain amount of proliferation of the surrounding connective tissue, and other mesoblastic tooth elements are often found in the tumors. In fact connective tissue proliferation may overshadow the epithelial tumor and the section appear at first glance as a fibrosarcoma.

Three types of epithelial cells are described: (1) Cells of cuboidal shape which may present prickles characteristic of squamous-cell carcinoma, and can easily be mistaken for that tumor. (2) The tall columnar cells having

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an alveolar arrangement and forming a tumor commonly described by pathologists as cylindroma (3) Stellate cells which are characteristic of the enamel organ These three types of cell represent different phases in the differentiation of the cells from the original pavement epithelium of the gum to the enamel

In gross, the tumors appear as multiple cysts centrally placed in the jaw, varying up to two or three centimetres in diameter and associated with a certain amount of solid tissue The cysts expand the jaw, destroying the cortex If the tumors obtain a large size, there is marked deformity and they may present under the mucous membrane of the alveolar process as a fluctuating area In the lower jaw they usually arise near the angle

The impression obtained from reading the literature is that the tumors are benign and although this is usually true, the growths are epithelial in origin and potentially malignant Bloodgood⁴ states that the tumors do not metastasize in the true sense of the word, but that implantation metastases in the soft parts may follow incomplete removal Bump found only two cases of glandular metastasis in the literature (Reported by Ewing) It is probable that the malignancy varies as in cancer according to the amount of differentiation of the cells, but this series is too small to allow of

conclusions being drawn In two of the twelve cases, however, there were glandular metastases These occurred late, were regional at first and, in the one case in which they were general, dissemination was not demonstrated until fourteen years after the onset of the disease Sections of a metastatic gland and of the primary tumor were available for study in both of these cases In Case II the glands in the neck appeared twelve years after the original tumor In the primary tumor cells of all types could be found, while in the gland the cells were more differentiated This patient is alive without evidence of disease eight years after resection of the jaw and dissection of the glands of the neck (Fig 5) In Case VII the tumor in the gland was similar to the primary growth The tumor was of the adenomatous and



FIG 3—Case 14, female, fifty eight years of age
Tumor of jaw of seven months' duration X ray showing the multiple cystic tumor of the lower jaw

cystic type with prickle cells, columnar cells, and a certain number of enameloblasts. The patient died fifteen years after the tumor was first noticed, with metastases in the glands of the neck, and lungs. Both of these cases had been operated upon several times.

A third case (Case X) presented clinical evidence of metastases in the glands of the neck, but his general condition contraindicated operation, and it has been excluded as no specimen was available for study.

The tumors are of very slow growth the average duration of the disease



FIG 4.—Case 4 female fifty six years of age. Tumor of lower jaw for thirty years. Four operations followed by recurrence the first having been performed twenty three years previously. X ray shows compound pathological fracture through the tumor (See Fig 5.)

in this series from the time the tumor was first noticed, until the patient was examined at the hospital being nine years. The shortest duration was seven months (Case III), while five were over five years, one being twenty-five years. The individual cases vary greatly in duration and course. In Cases I and III, the duration of the disease from the first symptom to death from local extension and sepsis was less than two years. In both of these cases the cuboidal type of cell predominated, and in fact, one was diagnosed twice as cancer and twice as adamantinoma by the same pathologist. In Case IV the duration from onset to the last observation was thirty-five years. Four operations had been performed on this case, each followed by immediate recurrence. X-rays had been taken yearly for the last ten years and showed no change in the tumor, and operation was finally performed for compound pathological fracture of the jaw. Microscopic examination of the specimen removed at the last operation showed the same structure as the tumor removed twenty-three years before. The growth was cystic in character and the cells almost entirely of the stellate form.

The usual history was that of a tumor of the jaw of slow growth without symptoms, which had had several minor operations performed on it, followed by immediate recurrence. In many instances it was obvious that the correct diagnosis had not been made by the physicians previously consulted. Several of these patients had been treated by dentists on the supposition that the cavity seen in the jaw by the X-ray represented a tooth abscess. Ten of the

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twelve cases had had some previous operative treatment varying from extraction of teeth or excision and drainage of the cyst, to partial removal. Case IX had not been operated upon but had received radiation treatment with temporary improvement.

Specimens from nine of the cases were available for review and represented types of all tumors described pathologically. Certain of the tumors were composed of multiple large cysts (Cases IX and XIV) while others (Cases V and XI) were macroscopically a single large cyst. Careful search



FIG 5 —Photomicrograph Case 4 (See Fig 4) The benign form of adamantinoma. The tumor was composed chiefly of multiple small cysts. The cells are of the columnar type.

through the sections revealed stellate cells in all cases. The relative proportions of the types of cell varied within wide limits in the different specimens. Case IV was the most typical section. The stellate cells predominated while cuboidal cells were rare. In Cases I and III, the tumor was practically solid and composed of cuboidal cells having the characteristic appearance of squamous-cell carcinoma although in certain sections the other forms of cells could be found. In Case IX the tumor was composed of cysts varying up to 2 cm in diameter, but sections of the more solid portions closely resembled microscopically the so-called adeno-carcinoma of the parotid. Cases VII and XIV were somewhat similar.

Sex —There were four males and eight females.

Age —The ages at the time of onset varied from thirteen to seventy-three years. Six cases were between twenty and thirty when the tumor was first noticed, while six were over fifty. One form of this tumor is more commonly

noted in late life, but it is difficult to say that careful examination would not have demonstrated it at an early date

Situation—Upper jaw—three cases, lower jaw—nine cases In the lower jaw, the disease usually arises in the body near the angle but any portion of the bone may be involved When seen through the mouth the tumor appears as a bulging of the alveolar process, more marked on the external surface, often about a sound tooth In the more advanced cases, the disease usually extends beyond the midline In the upper jaw the tumors often invade the

antrum but usually extend backward between the hard palate which is absorbed, and the mucous membrane of the nasal cavity In the three cases in which the upper jaw was involved, the tumors had extended beyond the midline in every instance

X-ray Examination—

The X-ray picture when the disease is situated in the lower jaw is usually characteristic There is a central area of bone destruction and the appearance is that of a single large or many small cysts Later when the growth has obtained considerable size, the bone may become entirely absorbed These tumors are confused usually with benign giant-cell



FIG 6—Case 5, female, thirty three years of age Tumor of seven years' duration Curettage six years previous with immediate recurrence X ray showing tumor of the body of the lower jaw extending forward from the angle At operation there was one large cyst with some solid tissue in the posterior portion from which the diagnosis was made

tumor or some other form of odontoma arising from the mesoblast elements, particularly the solid type often spoken of as central spindle-cell sarcoma, but the appearance of multiple cysts is characteristic It is also at times confused with small dentigerous cysts or osteomyelitis In the upper jaw the tumor extends to the antrum and the appearance is masked by the surrounding structure

In all the cases in which the lower jaw was involved, the X-ray was typical (Cases II, IV, V, VI, VII, VIII, XI, XIII and XIV In Cases VI and VIII, the films were not available for review but there was a good description of the findings

In the three cases in which the upper jaw was involved (Cases I, III and IX) it was possible to make the diagnosis from the X-ray in two cases only (Cases III and IX)

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Symptoms—There are no subjective symptoms characteristic of the disease. Objectively, there is a tumor of the jaw, centrally placed, with bone destruction and if the alveolus has been destroyed a fluctuating cystic area can usually be felt on the alveolar process or hard palate. In the more advanced cases there may be marked deformity, pathological fracture, and symptoms caused by pressure on adjacent structures or by secondary sepsis.

The diagnosis is made on the history of a tumor of long duration, and the X-ray. It is often impossible to make a definite diagnosis in an early case, but the probability of the growth being adamantinoma should be considered in all primary central cystic tumors of the jaw.

Contrary to the prevailing idea, the results of treatment of these cases as regards permanent cure by conservative operations were discouraging. Three cases (Cases I, III and XI) died of extension of the local growth and sepsis, two (Cases I and III) after two conservative operations, and one without treatment. The length of life in these cases from the onset of symptoms to death was seven years, one and one-half, and one year, respectively.

One case (Case VII) died of local recurrence and metastases in the glands of the neck and in the lungs fifteen years after the tumor was first noticed. Two operations had been performed on this case.

Seven cases (Cases II, IV, V, VI, VIII, XIII and XIV) had had from one to five operations performed, followed by a return of the disease and were living with local recurrence when seen by me from six to twenty-five years after the tumor was first noticed. Three of these cases have since had a radical operation performed, one, (Case II) had an excision of the lower jaw with dissection of the neck for metastatic glands and is well without evidence of disease eight years later. Two other cases (Cases XIII and XIV) had had excision of the lower jaw done one year ago and are living without disease at the present time. In the one case that had had radiation treatment (Case IX) excision of portions of both upper jaws was done fourteen months ago and there is no recurrence as yet.

In brief, ten cases had had conservative operations performed, and there was a recurrence in every instance. Of these, two cases (I and III) are dead from local extension of the disease and sepsis, and one, (Case VII) of metastases. Although obviously inadequate operations had been performed in many instances, in nearly every case one or more operations had been performed by competent surgeons who presumably removed all the visible tumor.



FIG. 7.—Case 2, female, thirty seven years of age. Tumor of fifteen years' duration. Operated upon four times with recurrence. Metastatic glands present in the neck. Photograph of specimen. The multiple cystic condition can easily be seen. The coronoid process is occupied by a large cyst and has the appearance of being hypertrophied. To the right of this is seen the articular process. Glands of neck removed. Living without recurrence eight years later. (See Fig. 8.)

CHANNING C SIMMONS

Bloodgood advises conservative operation but states that recurrence is common unless the operation is very thorough

In light of these results the appropriate treatment would seem to be wide local excision, that is, resection of the jaw. Recurrences are to be expected after conservative operations, although these are usually local and the tumor in the average case is of very slow growth, the patient remaining apparently well for many years. Metastases are also more common than is generally supposed and the fact that the tumor is composed mainly of well-differentiated cells is no proof that it will not metastasize. On the other hand, a woman



FIG 8—Photomicrograph Case 2 (See Fig 7) Section from the gland of the neck showing the tumor. A cellular form of adamantinoma composed chiefly of enameloblasts and columnar cells.

is very averse to the more or less mutilating operation of resection of a large portion of the lower jaw, and in young individuals with small tumors the conservative operation may be advised if the patient will agree to frequent examinations, and radical operation if there is recurrence. The prognosis in the individual case is difficult but I believe the more radical operation, that is, resection of the jaw, should be done if the cuboidal type of cell predominates in the tumor as this is probably the more malignant form of the growth, and it should also be done if the tumor is large. On the other hand, if the tumor is cystic and the prevailing cell on microscopic examination is the well-developed enameloblast, the probability is that the tumor is benign and any recurrence will be of slow growth and easily recognized. Case IV may be cited as an example of this type.

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The deformity following resection of the upper jaw is comparatively slight. It is possible to fit a plate closing the defect in the hard palate, obviating the difficulty with phonation and mastication. Following the resection of the lower jaw, the deformity is greater but in certain instances a prosthetic apparatus can be fitted, while in others a bone graft may be inserted to fill in the defect.

ABSTRACT OF CASES

CASE I—Male, fifty-three years. Tumor of left upper jaw of one year duration. Examination showed a tumor of the left upper alveolus from incisor to second molar. Patient operated upon and a large amount of tumor tissue removed. Radium inserted into cavity. There was slow recurrence and patient died of extension of the local disease six years later. Pathological examination showed a tumor containing numerous small cysts. In the first specimen removed the typical stellate enamel cells could be demonstrated, but the bulk of the tumor was composed of masses of cuboidal cells. A few cells of cylindrical type could be found in places. In a second specimen, removed three years later, no enamel cells could be found.



FIG 9—Case 13 male, thirty one years of age. Tumor of lower jaw six years. Local excision three years ago with immediate recurrence. X-ray of lower jaw. The multiple cystic tumor can be seen near the symphysis. There are large cysts extending in the body to the angle on both sides. (See Fig. 10.)

CASE II—Female, thirty-seven years. Tumor of the lower jaw of fifteen years' duration. Had been operated upon unsuccessfully four times. Examination showed a centrally situated cystic tumor in the left lower jaw, extending from the middle of the body to the articulation with bone destruction. Gland 4 cm in diameter at the bifurcation of the carotid. Two-stage operation with radical neck dissection and later resection of one-half the lower jaw. Pathological report of both tumor of jaw, and gland showed cells typical of adamantinoma. All types of cells were seen but less differentiated forms predominated. Living without disease eight years later.

CASE III—Female, seventy-three years. Tumor of left upper jaw four months. Had been incised. Examination showed multiple cystic tumor in the left upper jaw extending backward on the hard palate. X-ray showed increased density in the antrum. At operation an extensive tumor was found above the hard palate and below the nares extending into the antra on both sides. A large amount removed by morcellation and seeds of radium emanation inserted. Growth recurred in six months and did not yield to radiation therapy. Patient died about one year after operation. Pathological examination of the tumor showed solid masses of cells of cuboidal type which in places resembled cylindroma. A few areas presented the typical stellate cells of the enamel organ.

CASE IV—Female, fifty-six years. Tumor of the right lower jaw for thirty years. Patient had had four previous operations, two of which had been extensive. Examination

showed a centrally placed tumor in the right lower jaw near the center of the body, with a pathological fracture of the jaw, compound into the mouth with resulting osteomyelitis. The jaw was resected and microscopic examination showed a tumor identical with that removed twenty-three years before. Columnar cells and stellate cells predominated.

CASE V—Female, thirty-three years. Tumor of the right lower jaw removed seven years ago. This recurred one year later and has slowly increased in size. Right lower molars have been extracted. Examination showed a fluctuating cystic tumor in the alveolar process, occupying the posterior part of the ramus of the right lower jaw. X-ray showed bone destruction of the ramus of the jaw and the appearance of a multilocular cystic tumor. Operation—resection of portion of lower jaw containing tumor. Pathological examination—adamantinoma. Many large cysts and tumor cells, mostly columnar type, suggesting cylindroma. In places a few stellate cells.

CASE VI—Female, thirty-eight years. Two years before admission tumor appeared near the symphysis of the lower jaw, extending to both sides of the midline. The teeth were extracted. Examination showed a medullary tumor at the symphysis. X-ray showed bone destruction and the appearance of multiple cysts. Operation advised, and anterior portion of lower jaw removed by surgeon in another city. Recurrence one year later. Pathological report only. Adamantinoma in which the columnar cells predominated, but portions of the growth showed typical stellate cells with many large cysts. When last heard from, two years after excision, there had been a recurrence of the growth. Further operation was advised.

CASE VII—Male, thirty-seven years. Tumor of the right side lower jaw twelve years. Two incomplete operations. Glands removed from neck two weeks before admission, showed on pathological examination adamantinoma. Examination—a centrally placed cystic tumor occupying the lower jaw from the angle on one side to that on the other. Much deformity. Hard glands along anterior border of sternomastoid to the clavicle on both sides of the neck. No treatment. Three years later glands and tumor had both increased in size and there was evidence of lung metastases. Patient died one month later or fifteen years from the time the tumor was first noticed. Pathological report of tumor of jaw and gland showed same type of adamantinoma. There were many small cysts, the prickle and cuboidal cells predominated.

CASE VIII—Female, forty-two years. Twelve years before examination tumor appeared in left lower jaw. This was of slow growth but had been much more rapid in past four years and had been incised and curetted a short time before admission to the hospital. Examination showed a centrally placed tumor in the left side of the lower jaw extending from the incisor tooth to the angle. In places this was fluctuant. X-ray showed a centrally placed tumor with bone destruction and the presence of multiple cysts. Operation—a portion of the jaw containing the cysts was excised. Pathological examination showed a multilocular cystic tumor with a small amount of solid tissue containing columnar cells and a few stellate cells. The appearance was typical of adamantinoma of the cylindroma type. Letter received from patient five years after operation stated that the growth had recurred. She refused further treatment.

CASE IX—Female, sixty-eight years. Tumor of the upper jaw of six years duration. This had been previously treated by X-ray with some diminution in the rapidity of the growth at one time. Tumor had increased rapidly in size in the past year. Examination showed a cystic tumor 12 cm in diameter in the upper jaw extending from the region of the first molar on the left to a similar position on the right. Both antra were involved and the nasal cavity obliterated. Blood pressure 300. X-ray rather unsatisfactory but showed a multiple cystic tumor occupying both upper jaws. Operation—resection of the tumor with a greater part of both the upper jaws. Pathological examination—cystic tumor microscopically containing cells of cylindrical type characteristic of adamantinoma. In the greater portion of the tumor, the cells had an adenomatous arrangement.

ADAMANTINOMA

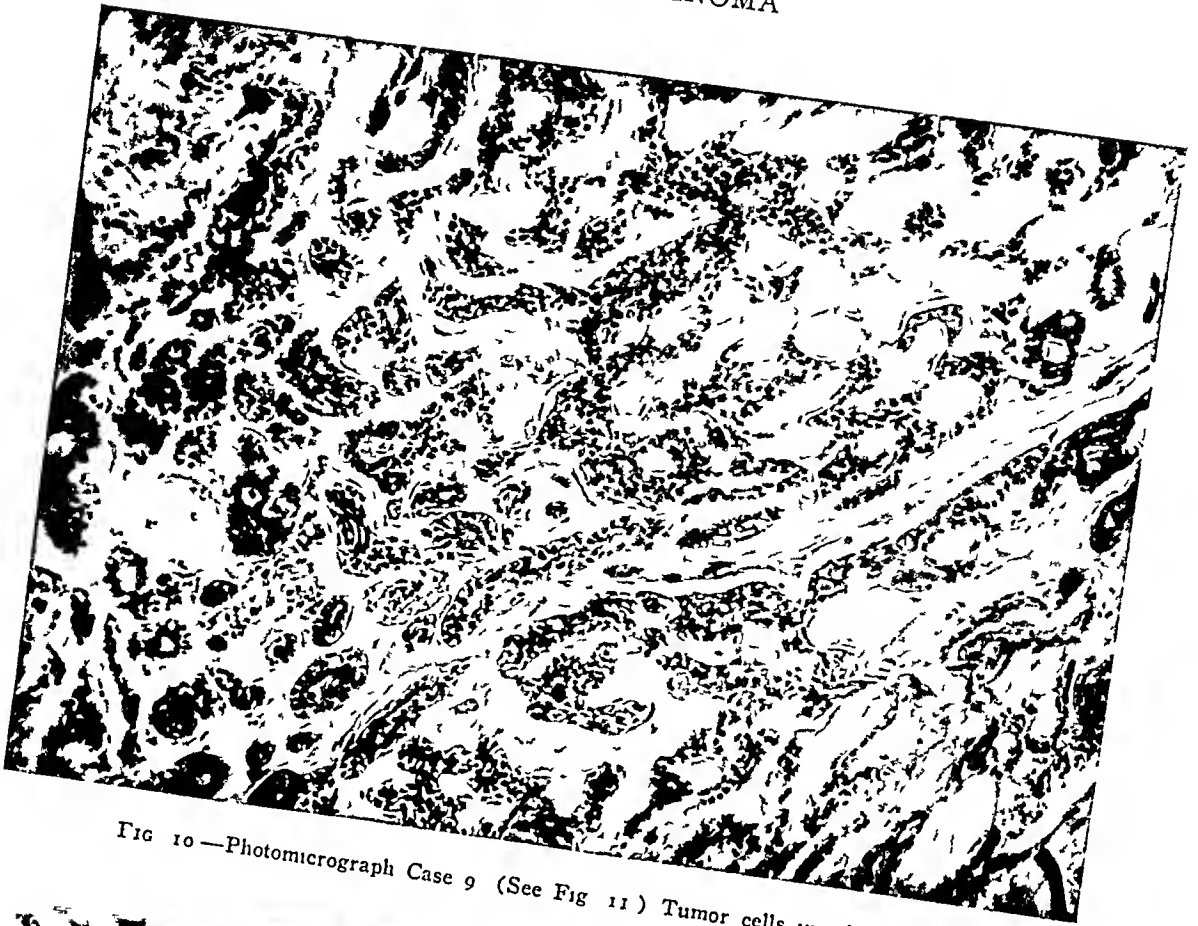


FIG 10 — Photomicrograph Case 9 (See Fig 11) Tumor cells invading bone

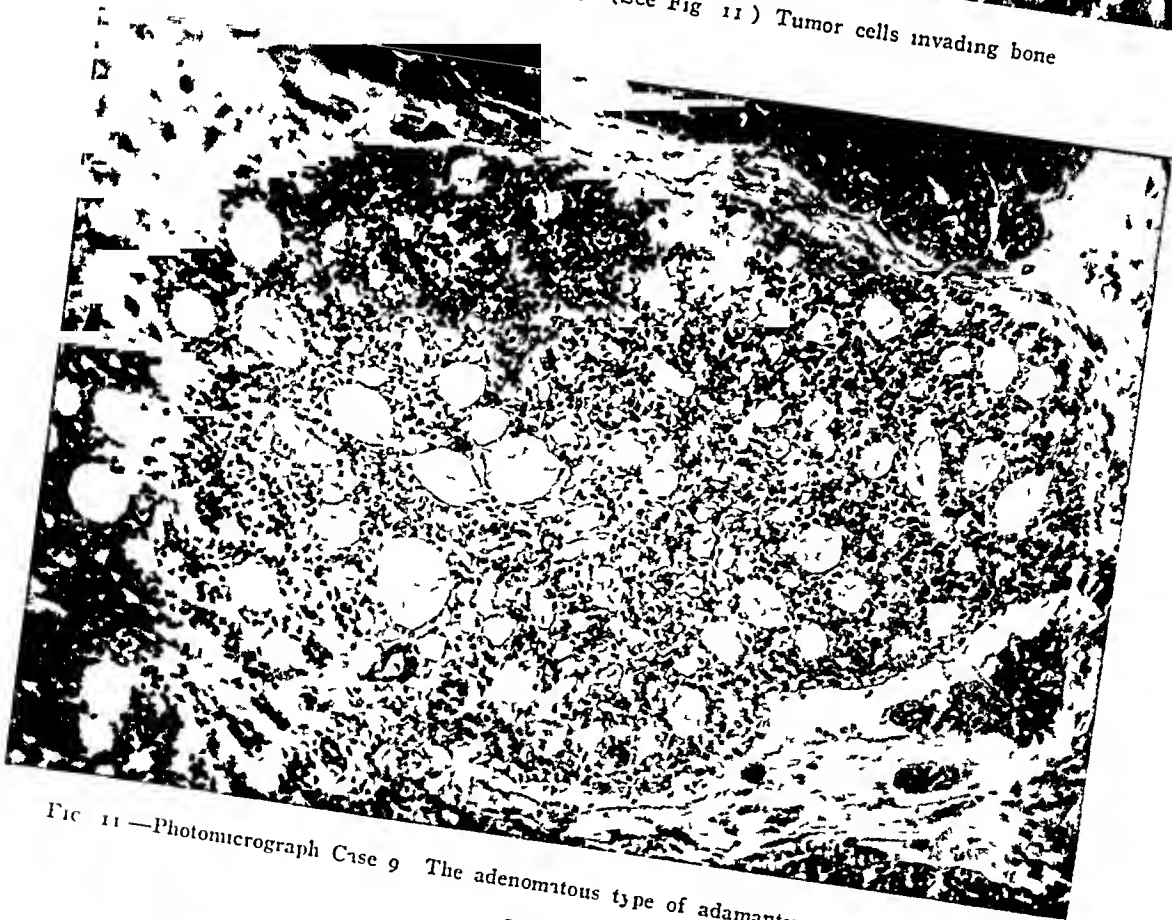


FIG 11 — Photomicrograph Case 9 The adenomatous type of adamantinoma (See Fig 10)

CASE X—Male, sixty-five years Tumor of right lower jaw for four years One previous incomplete operation Examination showed tumor of the right lower jaw near the angle, centrally placed and presenting multiple cysts There was a gland 4 cm in diameter hard, somewhat fixed at the bifurcation of the carotid This patient had prostatic hypertrophy, myocarditis and bronchitis He was not considered a suitable case for radical operation and, therefore, the diagnosis has not been confirmed by microscopic examination One year later following X-ray treatment the gland in the neck was smaller but the tumor of the jaw showed no change

CASE XI—Male, sixty-two years Tumor of the right lower jaw one year Teeth had been extracted Examination—at the region of the third lower right molar was a sinus extending into a cystic tumor of the jaw, centrally placed X-ray showed central tumor apparently composed of multiple cysts situated just anterior to the angle of the jaw Patient received no treatment and died nine months later Pathological examination showed solid masses of the cuboidal type of cell

CASE XII—Male, fifty-two years Tumor of the right upper jaw for twenty-five years First consultation with a physician was ten years previous to his admission to the hospital The tumor of the upper jaw had formed an abscess several times in the last two years Examination showed a tumor of the right upper jaw situated external to the antrum and extending from the canine to the molar tooth X-ray showed the typical appearance of an adamantinoma of the upper jaw There were multiple cystic cavities destroying the bone No operation was performed and the patient died twelve years after observation of intercurrent disease The tumor of the jaw had changed but little during this time

CASE XIII—Male, thirty-one years Colored Tumor of lower jaw originating in the right body of six years duration Growth excised without resection of the jaw three years ago Examination showed a large tumor occupying the lower jaw and extending from the angle of the left to a similar position on the right This was centrally placed and there were areas of fluctuation to be felt over the alveolar process X-ray showed a multiple cystic tumor Operation—excision of the entire lower jaw, the bone being divided anterior to the angles Pathological examination showed the tumor to be chiefly cystic but in places the typical stellate and columnar cells of adamantinoma could be seen

CASE XIV—Female, fifty-eight years Seven months before admission noticed tumor of the left lower jaw Teeth were extracted shortly after by dentist on the diagnosis of alveolar abscess and osteomyelitis Examination showed a smooth swelling occupying the left half of the lower jaw X-ray showed the tumor composed of multiple cysts which were typical of adamantinoma Operation—resection of the left half of the lower jaw from the symphysis to the angle Pathological examination—adamantinoma, chiefly cystic A few stellate cells but majority of the cells were of the cylindroma type

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CANCER IN AND ABOUT THE MOUTH

A STUDY OF TWO HUNDRED AND ELEVEN CASES

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THIS survey was not undertaken as a basis for any broad conclusions but rather to check our own work and results. We do not speak of cures, but believe that if we can add one year of healthful comparatively comfortable activity to the life of a useful man we have made a real accomplishment.

If a patient dies as the result of a sincere attempt to eradicate cancer, it is a bad mark against surgery, but economically it is no disaster. If after complete relief from a mouth cancer, the patient is later carried off by a recurrence in some vital organ, he has had not only the bene-

fit of the extra span of life, but has also been spared a much worse form of death, namely, from uncontrolled cancer of the mouth.

This presentation is facilitated by assuming the following growth sites. Out these regional distinctions were noted chiefly because of their relation to treatment, plan of operative attack and prognosis.

Cancer does not love rules, but it has preferences of location which in turn seem to influence direction of growth and, to some extent, quality of malignancy. Extension will occur from one area to another, but the site of the primary appearance here defines the location. There seem to be some general tendencies as to the direction in which the extension will occur.

The anatomical locations are (1) buccal cavity mucosa, (2) lip, (3) tongue and floor of the mouth, (4) face, (5) pharynx and tonsil, (6) neck, and (7) accessory nasal sinuses and nasal passages.

(1) The *buccal cavity mucosa* group includes growths of the gums and palate, often classed as cancer of the jaw, a classification that we disregard.



FIG. 1—Case I

because the bone involvement is accidental and only incidentally influences the plan of attack.¹ Metastatic carcinoma of the jaw has been noted three times, once from the rectum and twice from the breast. This buccal cavity mucosa division also includes those growths which have originated from within, but have perforated the cheek.

(2) The true *lip* cancers arise from the exposed vermillion border. In this group are included those cases which came to us with healed lips, the result of operation, radiation or pastes, but with metastatic growths in the neck. These have been fairly frequent and there have been some patients



FIG 2A—Case II

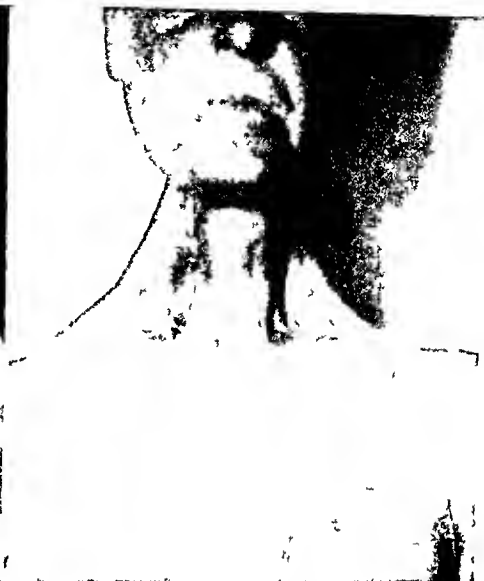


FIG 2B—Case II

who, when questioned, at first failed to remember that they had had a sore on the lip treated years previous to the appearance of the growth in the neck.

(3) *Tongue*, both oral and pharyngeal parts, and *floor of the mouth*. Growths of the floor of the mouth are grouped with the tongue, both on account of the frequency of the double involvement and of the therapeutic indications. The floor of the mouth is less frequently involved from the gums than from the tongue, and further, a growth on the gum is usually destroyed with a soldering iron, while the tissues of the involved floor of the mouth or tongue demand deep removal or radiation. From the tongue, a growth may extend widely into the cheek, fauces or pharynx, usually invading these tissues behind the alveolar process.

(4) *Face*, squamous-cell carcinomata arising from the skin, not including growths perforating from the deep structures.

(5) *Pharynx and tonsil*, growths arising in the oral pharynx.

(6) *Neck*, including tumors arising deep in the neck in patients in whom no primary site could be found. Treves pointed out the possibility of pri-

* The paradental epithelial cell remnants (paradental debris of Malassez) may possibly be the starting point of some malignant growths but we have found no definite evidence on this point.

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mary neck growths arising from epithelial remnants, but our observations are leading us to an increasingly strong belief that the majority of them are metastatic from unrecognized growths in the upper alimentary or respiratory tracts

(7) *Accessory nasal sinuses and nasal passages*, together with the naso-pharynx

We have also found it convenient to distinguish four arbitrary stages of growth as noted at the first examination (1) *Early* Growths of relatively short duration and where there is no gross

evidence of glandular involvement. These are frequently small enough for apparently complete excision for the biopsy. There were only ten in this stage out of a total of two hundred and eleven cases. (2) *Medium* More active growths, still not of great size nor involving tissues difficult to eradicate. Many of these

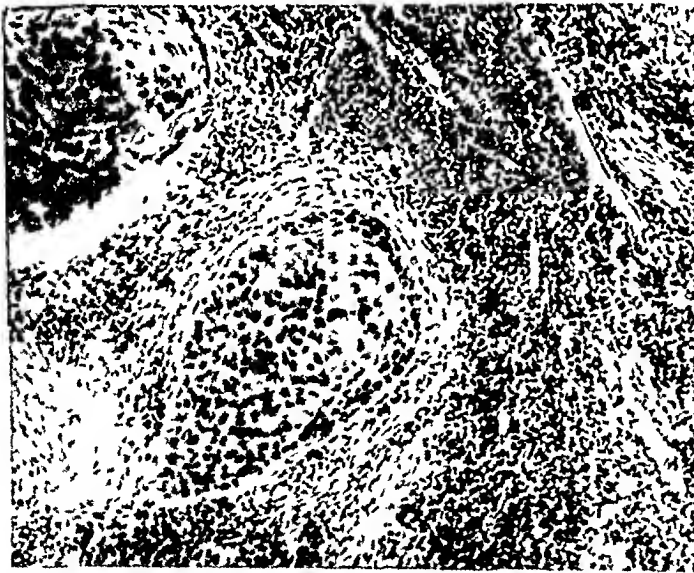


FIG 2D—Case II

patients have enlarged regional glands. Stages 1 and 2 are regarded as belonging to the likely curable class. There were thirty-five in this stage. (3) *Advanced* This stage includes growths which from their size or from the tissues involved render the treatment more hazardous and the prognosis distinctly less promising. There were one hundred and seventeen in this stage. (4) *Inoperable*

Growths too far advanced for any prolonged relief to be expected regardless of the type of treatment. A few are included in this stage because of physical disability, aside from the carcinoma. Radiation in some form was used in most of these patients. There were forty-nine in this stage.

Although there can be no fixed lines demarcating any one stage the classification has proved of practical use, as in cases of cancer of the mouth.

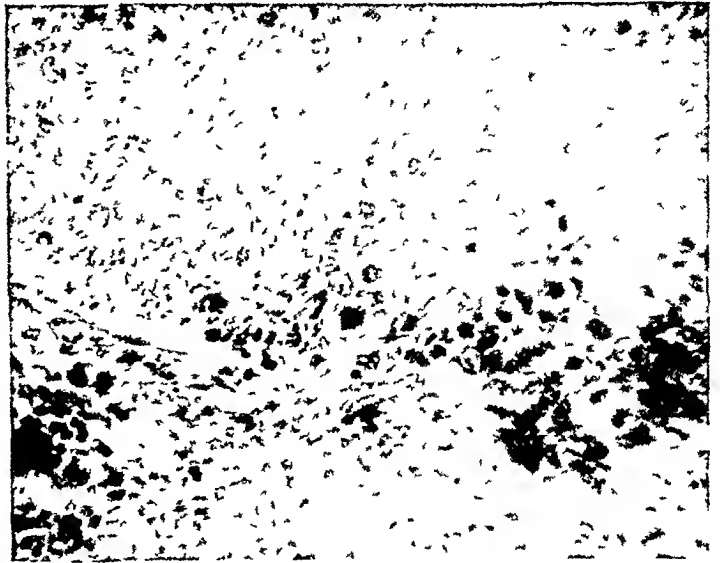


FIG 2C—Case II

patients have enlarged regional glands. Stages 1 and 2 are regarded as belonging to the likely curable class. There were thirty-five in this stage. (3) *Advanced* This stage includes growths which from their size or from the tissues involved render the treatment more hazardous and the prognosis distinctly less promising. There were one hundred and seventeen in this stage. (4) *Inoperable*

from clinical findings. The size, the duration, the rate of growth, the histology and the condition of the patient are all given consideration in summing up the prognosis and in planning treatment. No one criterion has been

found to offer a basis of prognosis accurate enough to present a percentage plan to the patient of his chances of life.

Some of the advanced and inoperable cases have not had biopsies, and in a few others, the microscopic sections were not available. An attempt has been made to grade these growths according to Broder's classification (Figures 13, 14, 15 and 16). In some cases several slides have been stud-



FIG 3A—Case III

ied, the ones from the biopsy, those from the specimen at the operation and those from the regional glands. In some of the earlier cases, biopsy was rather avoided for fear of spreading the disease, but we now feel strongly that there are advantages in the pre-treatment microscopic study that outweigh the dangers. By the total removal of small growths, or by the use of the cutting cautery for biopsy combined with radiation, the dangers of implantation must be materially reduced.

Throughout this series, an attempt has been made to correlate histology with the other factors, taking into account cellular differentiation, mitoses and the distribution of the cancer cells, but individ-

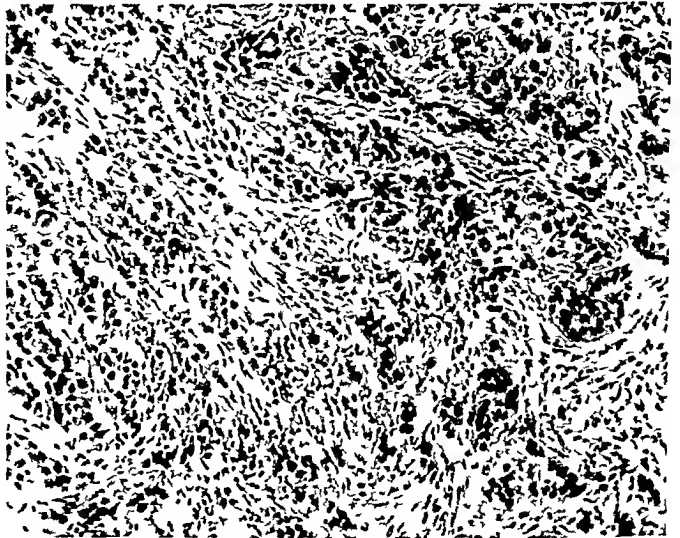


FIG 3B—Case III

ual ideas influence microscopic grading perhaps much as they do in determining clinical stages. While it may be claimed that one cell or a small group of cells may prove malignancy, various stages of differentiation may often be demonstrated in a single section. This necessitates a fairly thorough examina-

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tion and final balance of the differentiated and undifferentiated cells in determining the group. In spite of these uncertainties, it would appear quite certain that there is a definite relationship between the stage of cellular differentiation and the virulence of the individual growth. Therefore, this latter has a bearing on prognosis and on the character and extent of the treatment.

Our clinical observations over a much larger series have led to the rather definite conclusion that many growths are for a time held in relative abeyance,

TABLE I

Stage	Early				Medium				Advanced				Inoperable			
Grade	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Buc cav				2	7	2	I	I	4	17	7	7		2		4
Lip		2	I		3	3			3	3	4	7				2
Tongue	I			I		2	2	2	I	6	9	7	I			I
Face	I				I	I		I	2	I	I	4				I
Pharynx									I	I	2	2				5
Neck							I			I		4				4
Antrum								I				6		I		I
	2	2	I	3	11	8	4	5	11	29	23	37		4		18

Total graded—158
 Grade I —24
 Grade II —43
 Grade III—28
 Grade IV—63

Stage	Early	Medium	Advanced	Inoperable
Buc cav	2	16	41	17
Lip	3	6	20	6
Tongue	3	7	25	7
Face	2	4	11	1
Pharynx			8	6
Neck		I	5	8
Antrum		I	7	2
	10	35	117	49

Total—211

but later take on much more rapid growth, if not a real increase in malignancy. The opportunities to make early and late microscopic examinations on the same growth are relatively rare, but this series shows a higher percentage of growths of Grades 3 and 4 in the advanced and inoperable cases than in the early and medium cases. In drawing this conclusion, changes of only one degree were not considered of worthy note (Table I).

We have observed a type of growth that occurs in the mouth that very closely resembles cancer in its clinical progress and its outcome, but in which repeated microscopic examinations do not show the typical breaking through of the epithelial cells, which is considered necessary in the definition of cancer. These might rightly be considered as a precancerous stage, and in several

a breaking through of the cells has been demonstrated in a very small area of a relatively large growth. However, several have grown for long periods of time, have attained large size and have accomplished great destruction without any breaking-through being demonstrated (Case I)

When carcinoma could be demonstrated in the glands, the degree of malignancy nearly always approximated that of the primary growth. The glands were graded one grade lower seven times, one grade higher four

TABLE II

The grade of the metastatic growth rather closely followed that of the primary tumor

Of 114 gland examinations, 65 were found to be carcinomatous

Of 65 glands with positive carcinoma, 60 were graded

Of the 60 graded metastases

7 were Grade I — Of these 6 came from Grade I primary growths,
1 from a Grade II growth

9 were Grade II — Of these 7 came from Grade II primary growths,
2 from Grade III growths

14 were Grade III — Of these 1 came from an ungraded primary growth,
1 from a Grade II growth,
8 from Grade III growths,
4 from Grade IV growths

30 were Grade IV — Of these 8 came from ungraded primary growths,
1 from a Grade II growth,
3 from Grade III growths,
18 from Grade IV growths

1 undifferentiated growth in a lymph-node came from a primary adeno-carcinoma of the tongue

4 were not graded — 2 from ungraded growths,
2 from Grade II growths

In 49 glands, no carcinoma was found. Of these

1 was from an adeno-carcinoma of the cheek,

7 were from ungraded growths,

9 were from Grade I growths,

15 were from Grade II growths,

8 were from Grade III growths,

9 were from Grade IV growths

times, and two grades higher one time. Glandular metastases appearing long after the apparent eradication of the primary growth were practically always of the third or fourth grades, and, where the data was available, were found to have come from growths of original high malignancy. No malignancy was found in forty-nine out of one hundred and thirteen gland examinations, but this does not necessarily mean that these glands were not affected. When cancer was microscopically demonstrated in the glands, there were seven Grade 1, nine Grade 2, fourteen Grade 3, and thirty Grade 4. Of five that were not graded, one was a very malignant adeno-carcinoma from the only adeno-carcinoma of the tongue in the series (Table II)

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In most cases, the glands were removed by radical block dissection. The failure to demonstrate metastases microscopically does not mean necessarily that there was no glandular involvement. Results are, of course, better in the group where no carcinoma was demonstrated, but there are cases in the series which show that undifferentiated carcinoma, even affecting the glands

TABLE III
Longevity Relative to Lymph-node Infection

Grades	No carcinoma	I	II	III	IV
Alive 1-5 years	17	2	2	2	5
Alive 5-12 years	10		1	5	1
Post-operative deaths	6	2	1	4	7
Treated cases, dead later	8	2	3	1	5*
Treated cases not traced	7	1	2	2	1
	48	7	9	14	19

* One suicide

of the neck, is not an absolutely hopeless situation. However, these cases call for the most extensive removal. See Cases II and X. There were seven Grade 3 cases that had glandular metastases still alive three, four, seven, seven, eight, eleven and twelve years after treatment, six Grade 4 after one, one, two, three and a half, four and seven years, and one Grade 4 case that

TABLE IV
Longevity Relative to Stage and Grade of Primary Growths

	Stage			Grade			
	Early	Medium	Advanced	I	II	III	IV
Alive 1-5 years	2	12	23	8	8	6	8
Alive 5-12 years	3	9	8	4	7	5	1
Post-operative deaths	1		28	3	3	8	11
Treated cases, dead later	1 suicide		32	4	8	6	13*
Treated cases not traced	3	8	11	5	8	2	6
	9	29	103	24	34	27	39
Per cent cured or well	66	72.4	32†	50	43	40.7	23

* Eight refused treatment or went elsewhere for it

† Forty-three per cent if the post-operative deaths are not counted

Twelve more patients have been added to the 1-5 year group since this table was made

lived three years before a recurrence. (See Cases II, III, IV, V, VI, VII, VIII and IX. Tables III and IV.)

The results of treatment can best be shown in tabulations. There is a very high operative mortality, an average of 21.5 per cent according to the number of patients. In this series, one hundred and eighty-nine major operations were done on one hundred and thirty patients. All but one of the

post-operative deaths occurred in advanced cases where very radical operations were done, and the growths in nearly all of the cases were poorly differentiated ones. It seems that the farther back in the mouth and pharynx

the operation is carried, the higher the mortality. This may be due in part to the increased inability to get rid of mouth secretions, either externally or by swallowing, which predisposes to respiratory infection. Stamina on the part of the patient and constant efficient attention by the nurse do make for better results. Some patients fail to give any help of themselves. When tracheal tubes are in place,



FIG 4A—Case IV

expulsive coughing occasionally through the day will do more to clean out the trachea and bronchi than anything else, but it has been impossible in some instances to keep the airway clean by any means, including suction. Radiation

to temporarily stop the salivary flow has been considered, but not tried so far, because, in spite of the annoyance of it, it often seems to be the one thing that keeps the total secretion movable so that it can be gotten rid of. Death occurred nineteen times from pulmonary complications, three times from cardiac complications, three times from hemorrhage. Of four cases in which the common or internal carotid artery was tied four died. Two of these, however, apparently died of pneumonia (Table V).

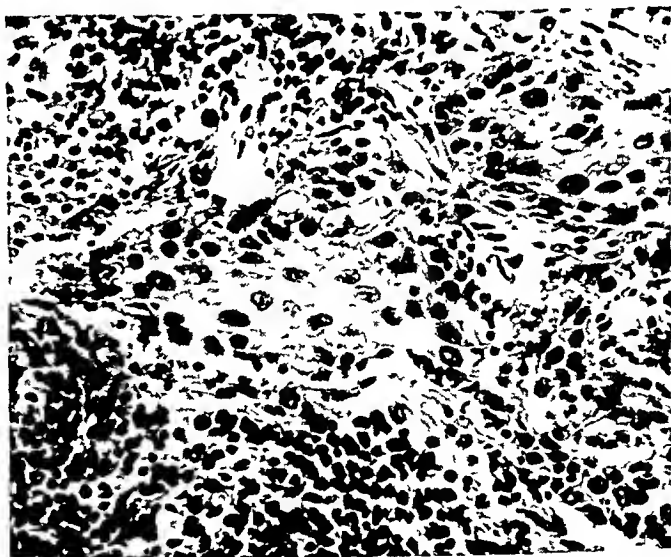


FIG 4B—Case IV

Of the treated early cases, 66 per cent are supposed to be cured. Of the treated medium cases, 72.4 per cent are alive, and of the treated advanced cases 32 per cent are known to be alive and without known recurrence. Of

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those advanced cases that survived operation, the percentage still alive is 43 per cent †

The percentages of living patients without known recurrence, with growths of Grades 1 2 3 and 4, are 50 per cent, 43 per cent, 40.7 per cent and 23 per cent respectively. Untreated cases do not figure in these percentages, but those lost track of are counted. No reports could be obtained on forty-

TABLE V

Post-operative deaths	29
Stage of growth	28 advanced 1 early
Grades	Grade I 3 cases Grade II 3 cases Grade III 8 cases Grade IV 11 cases Ungraded 4 cases
Cause of death	
Pulmonary complications	19
Cardiac complications	3
Secondary hemorrhage	3
Common or internal carotid ligation (2 from pneumonia)	4

Death occurred from 1 to 42 days after operation
Average time of death—10½ days after operation

	Total cases	Radical operations	Neck diss	P-oper deaths		Total no oper at separ times
				Number	Per cent	
Buccal cavity	76	53	44	14	26.5	76
Lip	35	22	21	2	9	31
Tongue	44	26	23	7	26.9	42
Face	18	12	4			14
Pharynx	14	8	6	3	37	10
Neck	14	6		2	33	6
Antrum	10	8	1	1	12.5	10
	211	135	99	29	21.5 (Average p-oper death rate)	189*

* The post-operative death rate according to the number of operations is, of course lower than that according to the number of patients

one patients. Of these, twenty-eight are probably dead and thirteen are possibly alive.

There are seventy known deaths other than the post-operative ones. Of these, thirty-four had been treated by operation and radiation and thirteen by radiation, sixteen refused treatment or were sent home for radiation, seven were untreated. Subsequent death from cancer is recorded in twelve or fifteen cases. All but three of these cases were advanced or inoperable,

† Most of the late reports on the patients have been obtained by the Social Worker on the Surgical Service.

and there were four Grade 1 growths, ten Grade 2, seven Grade 3, and twenty-one Grade 4

CASE I—Male, fifty-nine, white Three years before admission, the patient's lips became painful and reddened, and he noted a lump in his cheek One year ago, lips and growth on right cheek became worse He was given elsewhere four radium treatments and "electric destruction" three times

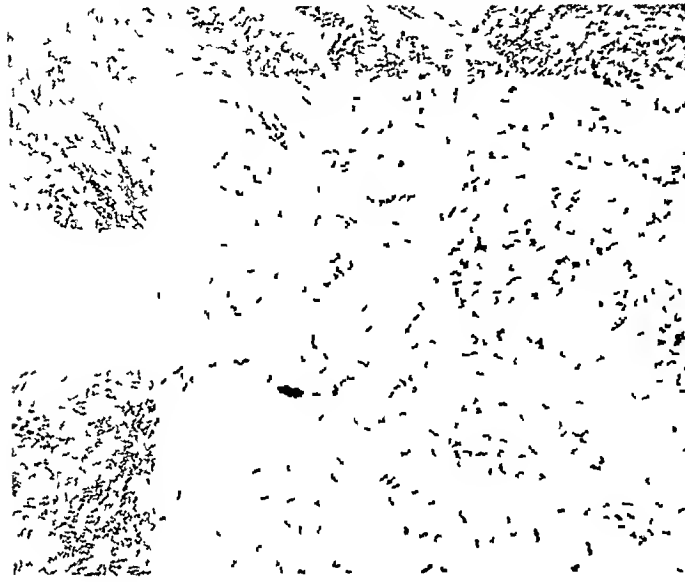


FIG 5A—Case V

Upon admission, the epithelium of the lip was found to be reddened, thinned-out, cracked and painful There was a widespread, smooth leukoplakia over the right cheek as far back as the molar region In the molar region, there was a papillomatous ulcer one and one-half centimetres in diameter The edges were firm and everted, but not as hard as is usually seen in cancer The process extended into the upper fornix and because of

thickening and an abscess deep in the cheek, the mouth could not be opened over one and one-half centimetres On the outside, there was a dome-shaped induration over the centre of the cheek with a small opening draining pus from deep within the cheek

The specimen removed showed a verrucous growth one and one-half centimetres in diameter The borders were fairly well demarcated, but were found to extend down into the ulcerated area in the cheek The microscopic picture resembled a benign papillomatous growth rather than a true cancer, as may be seen in the microphotograph It was because of this picture that three biopsies were done before radical operation was instituted (Figure 1)

CASE II—Male, forty-six, white The patient noticed a small tumor in the floor of the mouth three months before his admission to the hospital He had received no treatment

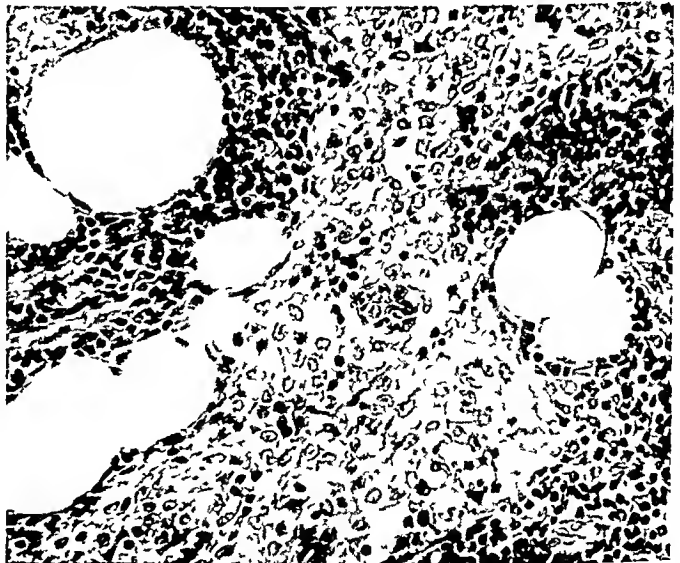


FIG 5B—Case V

Examination showed a smooth, flat ulcer in the left side of the floor of the mouth, not more than one centimetre in diameter No enlarged regional lymph-nodes were felt Without previous biopsy, because we had learned to regard this clinical picture as denoting high grade malignancy, an excision of half of the tongue was done, followed four months later by a left neck dis-

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section Two years later a right neck dissection was done, on account of recurrence on this side The photographs were taken seven years after the first operation, and show the extremely radical neck dissections that are done on these cases (Figure 2, A and B)

Pathology—The type of growth this tumor illustrated may be seen in Figure 2 C The cancer cells are very poorly differentiated and mitoses are abundant The primary growth has been given a Group 4 grading In Figure 2 D, taken from one of the regional glands, there are two areas distended with cancer cells and surrounded by adenoid tissue Mitoses are not as frequent as in the initial lesion, but even here differentiation is not especially good From a study of this and other areas, the gland metastases have been given a Group 3 grading

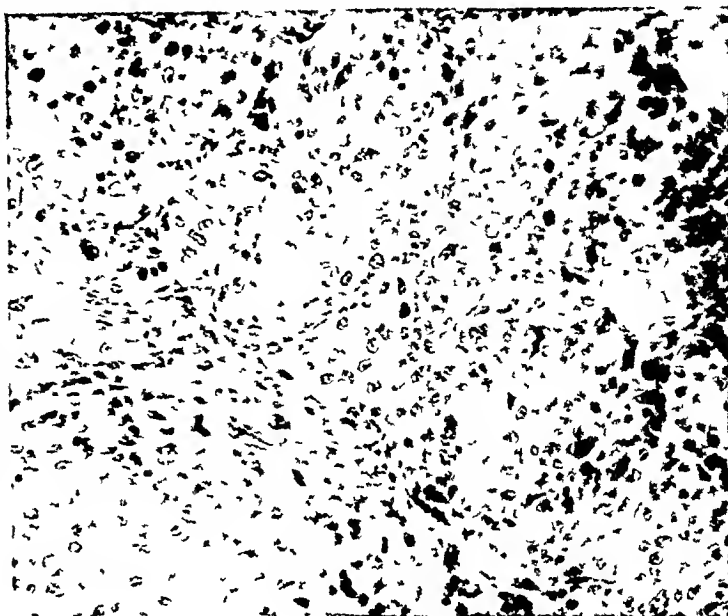


FIG 6—Case VI

CASE III—Male, fifty-one, white One year before the patient was seen, he noticed a blister at the mucocutaneous border of the right lower lip near the angle Four months later a mass appeared beneath the right jaw

Examination showed an ulcer at the corner of the right lower lip 2 x 1 centimetres The ulcer was shallow, with a dry, gray base and with hard everted edges A right submaxillary lymph-node was



FIG 7—Case VII

very large, hard and movable

A right neck dissection was done, with a large V-shaped excision of the ulcer The patient is well now, eleven years after the operation

Pathology—Figure 3 A is taken from the primary growth There is abundant keratinization present The marked inflammatory reaction present is perhaps due to the proximity of the ulcer, Grade 3 Figure 3 B is from one of the regional lymph glands The normal architecture of the gland has given way to the extensive carcinomatous proliferation Differentiation

is not as complete as in the primary lesion There is practically no hyalinization and numerous mitoses may be seen Fairly extensive fibrous tissue proliferation is present This gland has been graded 3

CASE IV—Male, fifty-six, white Three and a half years before admission into the hospital, the patient noted a small ulcer beneath the tip of the tongue This was excised locally and was said to have been diagnosed microscopically as a benign lesion There

was a recurrence within two months. For the last nine months before admission, there had been considerable bleeding and pain.

Examination showed a large ulcer involving the entire under-surface of the tongue and a portion of the floor of the mouth on the right side. The edges were hard, everted,

tender and bled easily upon manipulation. There was a mass in the upper left part of the neck fixed to the jaw.

Following a low tracheotomy, there was simultaneous bilateral upper neck dissection and removal of the tongue and floor of the mouth, and deep cauterization of the body of the mandible.

Seven years later, a new focus developed in the larynx that apparently was unrelated to the previous growth. In spite of treatment, the process extended deep in the neck.

Pathology—In Figure 4 A, very little hyalinization is seen. In spite of the spindle



FIG 8—Case VIII

shape of the cells seen in this area, this tumor has been given a Grade 3. Other areas from the tumor showed even poorer differentiation with marked invasive properties. Figure 4 B shows an early metastasis to a regional lymph gland. The clear cancer cells may be seen surrounded by fairly normal lymphoid tissue.

CASE V—Male, forty-eight, white. The patient had noticed a lump on the tongue five years previously which was then excised. He sought treatment for a recent recurrence.

Examination upon admission showed a hard, red, ulcerated area involving most of the upper surface of the tongue. The edges were everted and showed a tendency to bleed. The tongue was hard, swollen and tender. There were palpable glands in both submaxillary triangles.

A tracheotomy was done followed by a complete removal of the tongue with an upper neck dissection on both sides. The patient returned at later dates for lower neck dissections on both sides, and for excision of a small nodule just above the clavicle that proved to be inflammatory in origin. The patient is well now and able to continue his profession as a physician twelve years after the operation.

Pathology—Figure 5 A, from the primary growth, shows good differentiation of the carcinoma with tendency toward pearl formation. There is a widespread



FIG 9—Case IX

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FIG 10A—Case X

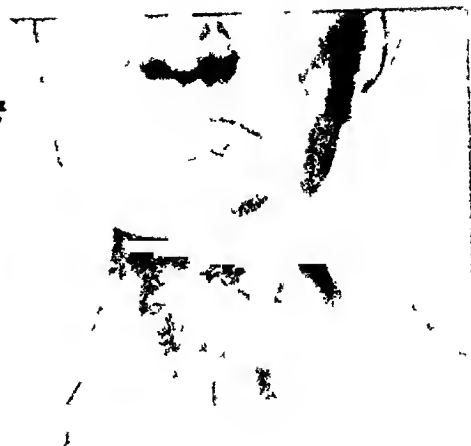


FIG 10B—Case X



FIG 11A—Case XI

inflammatory reaction due, no doubt, to the proximity of the area seen here to the ulcer Grade 2

Figure 5 B shows early invasion of a regional lymph-node. Differentiation is not quite so good as in the primary lesion. The large pale cancer cells may be seen surrounded by adenoid tissue containing dilated lymph spaces Grade 3

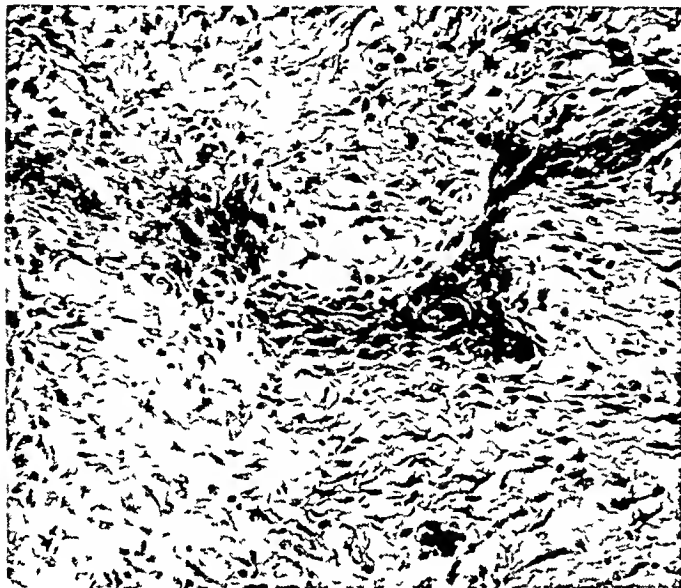


FIG 11B—Case XI

dissection of the upper part of the right neck, including the parotid gland

Pathology—Figure 6. Differentiation is poor. There is considerable anaplasia present. Mitoses may be seen. Cell outline is in many places indistinct, giving the appearance of a syncytial arrangement Grade 4. This patient has had no recurrence following the primary excision of the tumor, four years ago

CASE VII—Male, forty-five, white. Onset one year before admission, with hard, painless nodule back of ear. This soon ulcerated. Several plasters were applied. The growth increased rapidly in size. X-ray therapy was given. Since then, there has been considerable pain.

Upon examination, an oval ulcer $2\frac{1}{2} \times 2$ centimetres was noted back of the left ear with a rolled, hard border and about five millimetres in depth. There were palpable lymph-nodes on both sides of the neck. There was a generalized hyperkeratosis of the skin.

The patient had a complete left neck dissection with removal of the parotid gland, and is well now three and a half years after the operation.

Pathology—Figure 7. There are masses of carcinoma cells surrounded by a dense



FIG 12A—Case XII

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fibrous tissue stroma. Here and there spindle cells may be seen, but from a study of the section as a whole this tissue has been given a Grade 3. Sections from the glandular metastases not shown here present approximately the same picture.

CASE VIII—Male, sixty-four, white. Fourteen months before this patient was seen by us, he noticed that his throat was becoming sore and that the tonsil on the right side was red. He had received no treatment.

Upon admission to the hospital, the right tonsil and anterior pillar were found to be almost completely destroyed by a dirty ulcer extending up to the hard palate. There was an enlarged gland in the anterior triangle of the right side of the neck.

Radium therapy was followed by a complete neck dissection on the right side. Several weeks later, following a tracheotomy, a radical excision of the tumor was done along with excision of one-half of the tongue. This was followed by further radium therapy. He is well now, seven years after the first operation.

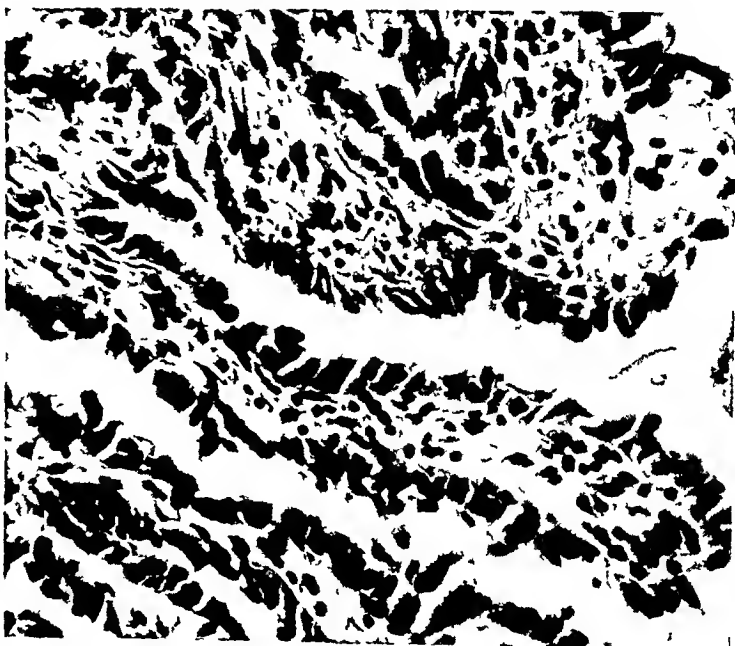


FIG. 12B—Case VIII

Pathology—Figure 8. In spite of very definite cellular outline, there is no prickling or hyalinization. In other areas, the resemblance to squamous cancer is still less. Very little stroma is present. This cancer has been given a Grade 4.



FIG. 13—The section shows epithelial proliferation in a fairly dense fibrous area. Pearl formation is present and cell differentiation is complete enough to group this tumor as a Grade 1.

and not especially tender. There was a mass behind the ramus of the left jaw, apparently continuous with the mass in the pharynx. An enlarged lymph gland was felt at the angle of the left mandible.

A complete lower neck dissection was done on both sides followed by removal of

the tongue, the floor of the mouth and the upper lymphatics at a later date. The patient died eight years later of lobar pneumonia, without further evidence of carcinoma.

Pathology—Figure 9 This section has been taken through one of the regional lymph glands, the normal architecture of which has been greatly distorted. In spite of the fact that no epithelial pearls were seen and no prickling, the flattening out of the cells and hyalinization has given it a Grade 2.

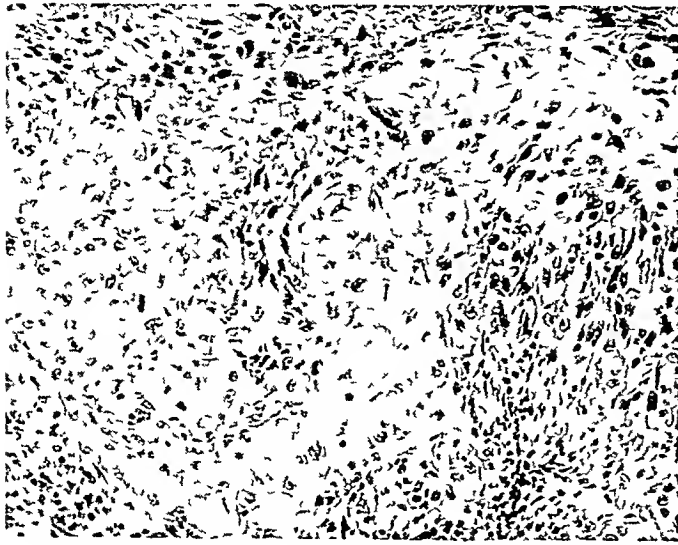


FIG. 14—The cells are flattened and show a fair amount of hyalinization. However, there is considerable variation in the size and shape of the cells. Some mitoses are present. This carcinoma has been given a Grade 2. It probably should be more properly considered in a grade between Grades 1 and 2.

to the posterior faucial pillar of the right side. There was one large lymph-node at the bifurcation of the carotid on the right side.

A preliminary tracheotomy was done followed two weeks later by complete excision of the tongue with an upper neck dissection on both sides. Later, a lower right neck dissection was done. Several weeks after this, a lower left neck dissection was performed. Figure 10 A and B, taken three years after the operation, show the neck following the block dissections. Both internal jugulars and sterno-mastoid muscles are absent. The patient has a fair voice and is making his own way. The carcinoma was of low Grade 1 malignancy.

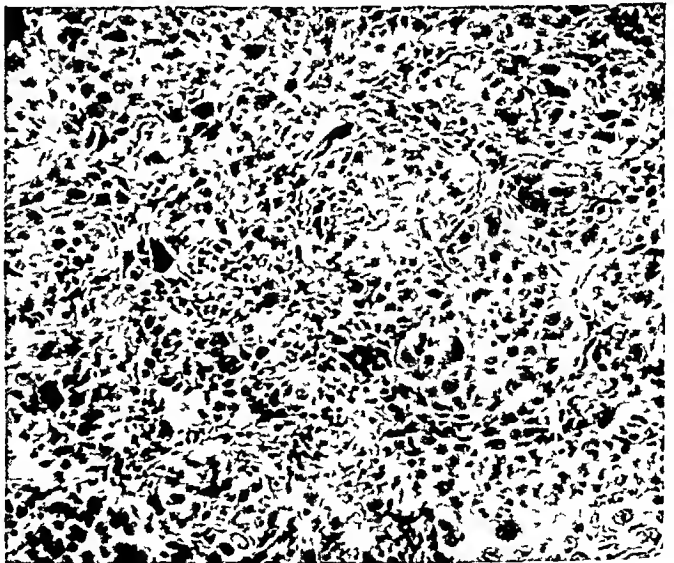


FIG. 15—There is very little keratinization. There is a marked variation in the size and shape of the cells. Mitoses are easily demonstrated and giant cell formation may be seen. There is very little fibrosis present. The poor differentiation has placed this carcinoma in Grade 3.

CASE XI—Male, forty-eight, white. About two years before admission to the hospital, the patient noted a small ulcer on the mucous membrane of the right cheek in the molar region. He used caustics locally without improvement and later consulted a physician. He was given two radium applications followed by a local excision of the ulcer two months later. There was a recurrence

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which was removed with the actual cautery. Following this he had four X-ray treatments.

Upon admission to the hospital, a hard ulcer was found in the right cheek opposite the molar region with induration extending down to the mandible. The ulcer crater was 2 centimetres in diameter. The cheek was swollen and reddened.

This patient had extreme pain before entrance to this service. He had been keeping cocaine in his mouth on the areas, had required a good deal of morphine and had taken large amounts of whiskey to try to get relief. Operation in this instance was decided upon for the added reason of getting rid of pain.

A cautery excision of the growth with removal of most of the right mandible and part of the maxilla, and an upper right neck dissection was done. Two weeks later, radium was applied to the wound edges and neck. At the time of discharge from the hospital, pulmonary metastases were noted. The patient died two months later. The metastases were probably present, though unrecognized, at the time of operation. In spite of the wide destruction and the outcome, the patient and his family welcomed the relief from pain the operation gave. (Figure 11 A.)

Pathology—Figure 11 B. Tissue removed from around the ulcer edge showed no carcinoma, but merely dense fibrous tissue. The section shown here was taken from a hard sclerotic area around the mandible. The stroma is dense and abundant presumably the result of radiation. The cancer cells show a moderate degree of differentiation. In other areas not shown here

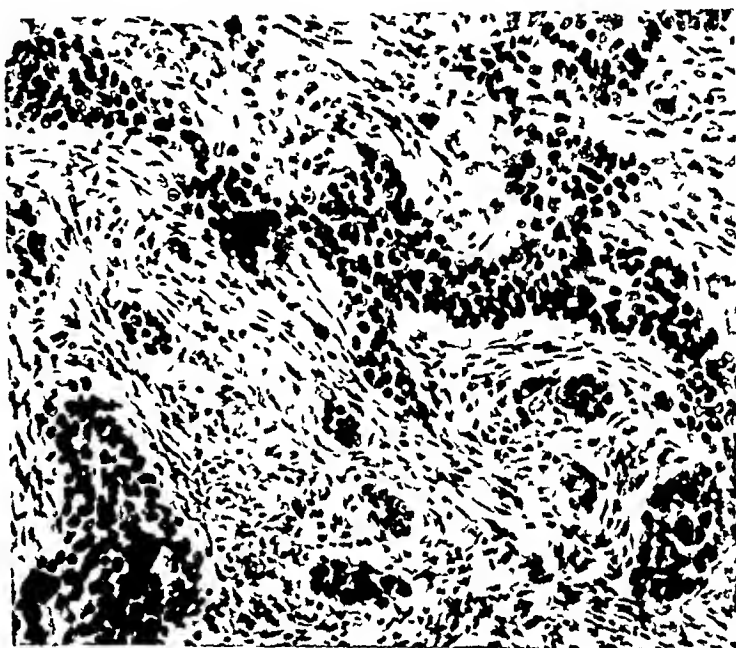


FIG. 16.—From the structure of the above section, it is difficult to say that this is a squamous cancer. Cell outline is indistinct and the nuclei are hyperchromatic. There is considerable variation in the size and shape of the nuclei. Mitoses are abundant. Many small lymph channels may be seen studded with the cancer cells. This tumor has been given a Grade 4.

there is considerable hyalinization. The regional lymph glands in this case showed no evidence of carcinomatous invasion. It is interesting to note that cancer cells were found beneath the mylohyoid muscle. Whether or not radiation has influenced the differentiation of the cancer cells is a conjecture, as we do not know the picture of the primary growth.

CASE XII—Male, fifty-six, white. Three weeks before the patient was admitted to the hospital, he noticed a small lump in the cheek.

Examination showed on the inner side of the right cheek a granular ulcerated tumor about 2½ centimetres in diameter, poorly defined and very hard. A few hard glands were felt just above the right clavicle.

A wide excision of this mass, including removal of the full-thickness of the cheek, was done with the actual cautery and several months later a neck dissection on the right side was performed. Following this he had a repair of the cheek. He is now well, twelve years after the first operation.

Pathology—Figure 12 A and B. This is apparently a true adeno-carcinoma, papillary in type, and is the only one in this series arising in the buccal mucosa. Figure B is a higher magnification of an area shown in A. One sees villi containing a delicate fibrous tissue stroma and lined by well differentiated, low columnar epithelium. There were no demonstrable metastases to the regional lymph-nodes.

SUMMARY

(1) Cases are grouped into fairly definite anatomical sites chiefly because of their relation to treatment and prognosis, and to facilitate classification, history taking and presentation

(2) The term "carcinoma of the jaw" is not used because bone involvement is secondary and only incidentally influences treatment

(3) Growths with wide extension or metastases are put in the group corresponding to the primary growth site Neck tumors do occur in which no primary growth site can be determined, but the majority of them are metastatic from some unrecognized upper respiratory or digestive tract growth

(4) Four arbitrary clinical stages are distinguished and are of practical use in giving a basis for treatment and prognosis from clinical findings

(5) Biopsies are done in most cases before treatment is begun, both for confirmation of diagnosis and for studying the relative degree of malignancy of the growth

(6) In arriving at a plan of treatment and prognosis, clinical and microscopical findings are considered together No one criterion has been found to offer a basis of prognosis accurate enough to present a percentage plan to the patient of his chances of life

(7) Growths may for a time be held in relative abeyance, but later take on much more rapid growth if not a real increase in malignancy In this series there is a higher percentage of undifferentiated growths in the late than in the early stages

(8) There has been observed a type of growth that in clinical aspects is cancer, but in which the microscopic picture does not show the typical definition of cancer These growths may cause great destruction if not treated at least locally as cancer

(9) The degree of malignancy of metastatic gland carcinoma followed fairly closely that of the primary growth There may be no microscopic evidence of malignancy in the regional glands, but this does not necessarily mean that the glands are not affected

(10) Though results are, of course, best in the cases where no carcinoma was found in the glands, there are cases in the series that show that undifferentiated carcinoma even in the glands of the neck is not an absolutely hopeless situation

(11) There is a high operative mortality, 21.5 per cent, all but one of the deaths occurring in advanced cases where very radical operations had been done

(12) The farther back in the mouth and pharynx the operation is carried, the higher the mortality This is probably due to increased liability to respiratory infection

(13) Results of treatment are tabulated

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DISCUSSION DR ROBERT B GREENOUGH, Boston, Mass, said that there was no question in his mind that the work Doctor Blair has been doing in the plastic repair of very extensive excisions in cancer of the mouth has opened up a field of useful surgical treatment in a group of patients that have been left very much without help in the past. He was thoroughly in accord with the statement that if we can only rid a man of a sloughing, offensive local lesion within the mouth for as much as a year's time, even if after that he dies of more remote metastasis, we have accomplished a great deal for that particular man's good.

These extensive operations can only be done by making use of the principles of plastic surgery.

As to the grading of the degree of malignancy of the tumors in the decision as to just what is to be done in the individual case, he had been very confident that as time went on this principle would be more widely accepted. There is no doubt that what can be done in a tumor case of low grade malignancy may be bad judgment in one of higher grade.

The two following tables show the results of operation in a series of cases of cancer of the lip and cancer of the buccal mucosa which were graded into three and four groups of malignancy according to the amount of differentiation of the cells. The tables explain themselves.

TABLE I

Cancer of the Lip, Results of Operation, Pathological Grouping

	Living Cases	Per Cent	Dead Cases
Group 1	53	81.5	12
Group 2	14	70	6
Group 3	4	22	14

Simmons and Daland (Surg, Gynec and Obst, 1922, vol XXX, p 766)

TABLE II

Results of Operation, Pathological Grouping

	Cases	Cures	Per Cent
Group 1	17	12	68
Group 2	14	3	21
Group 3	17	1	6
Group 4	11	0	0

Simmons (Surg, Gynec and Obst, 1926, pp 377-382)

These cases were observed at the Massachusetts General Hospital and the Collis P Huntington Memorial Hospital. The living cases were alive without evidence of disease three or more years after operation.

Doctor Blair had sent on to Boston a few sample slides from this series of cases that he has reported. Three different observers, Dr Channing C Simmons, Dr H F Hartwell, surgical pathologist at the Massachusetts General Hospital, and the speaker had reviewed these independently. As a result of the examination of these fourteen specimens of different grades of malignancy, following the Broders classification of four grades, in only

two instances did the estimates fall more than one grade apart. In other words, they were practically all agreed upon the cases of high malignancy, and of low malignancy, and only in the middle groups were there differences of opinion as between Class 2 and Class 3, and these differences were virtually insignificant.

This would seem to demonstrate that in general the method of applying this gradation principle to cancer cases was being done in a reasonably uniform manner. There will always be some differences of opinion, since the personal equation enters so largely in the estimate.

In one respect their principles in Boston had been a little different from those suggested originally by Doctor Broders. In classifying the squamous-cell tumors of the skin and mouth he attempted to estimate the percentage value of differentiation in the whole tumor. Supposing there was three-quarters of the tumor that was well differentiated, and one-quarter of the mass that was less differentiated, Doctor Broders would grade the tumor at a lower degree of malignancy than in one where those percentages were reversed.

With us, we have taken the position that the most malignant bit of tumor tissue that could be observed in the whole tumor was the one which was to be considered, so far as the prognosis was concerned, and therefore, in a tumor which was generally of a low malignancy if areas were found that were distinctly of a high grade, the case is classed as one of high malignancy.

DR CHANNING C SIMMONS, Boston, Mass., remarked that it is much easier to grade squamous-cell carcinoma pathologically than the cedematous forms, such as cancer of the rectum or of the breast, although this has been easier to grade squamous-cell carcinoma pathologically than the cedematous cancer. The clinical application of this is not yet entirely clear. It certainly is of great value in the prognosis of cancer of the buccal mucosa and lip, and has a distinct relation to the form of treatment which should be employed. For example, an extremely radical operation in this form of cancer is unnecessary if the tumor is of low-grade malignancy and small, while it should be done in every instance if the tumor proves to be of high-grade malignancy.

The term "cancer" applied to all the metastasizing epithelial tumors is in some ways unfortunate—cancer should be considered as a regional disease. There is nothing in common between cancer of the skin on one hand and cancer of the tongue and cervix on the other. A tumor that would be of low-grade malignancy in cancer of the tongue, Grade 1, is comparable to Grade 3 malignancy of the lip.

JUVENILE GANGRENE

BY WALTON MARTIN, M D

AND

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OF NEW YORK, N Y

FROM THE FIRST SURGICAL DIVISION OF ST LUKE'S HOSPITAL

I HAVE ventured to report four cases of gangrene of the extremities in young subjects, as such cases are unusual and their origin and manner of development imperfectly understood. I have thought it might be of interest to bring to your attention the reports of similar cases and to follow, as far as possible, the succession of happenings.

The first case, a boy four and a half years old, became acutely ill with temperature and symptoms suggesting a generalized infection. When seen three weeks after the onset, he had gangrene of the left foot, of both ears and of a circular patch of skin over the left patella. There was a systolic murmur over the apex of the heart and a to-and-fro pericardial friction rub heard over the sternum. The gangrenous areas separated and the foot sloughed through at the ankle-joint at the end of two months. The boy recovered and is well today, five years after his original illness. The skin over the stump of his leg, only a few inches above the original line of demarcation, is normal looking and movable. The skin of the stump of the ear is white and the scar looks as if a portion of the ear had been severed by a surgical operation (Fig 1, 2, 3, 4).

The second case I have recently seen in consultation, through the courtesy of Dr J V Bohrer of New York. A child six years old was lying in bed in a small flat. One hand and both legs were coal black, there were zones of suppuration where the living tissue was being separated from the dead. There was a recent healing scar on the external ear where a portion of dead tissue had fallen off. The boy had had an acute illness, apparently diphtheria, preceding the onset of gangrene (Fig 5).

The third case, a boy seven years old, had widespread chronic tuberculosis. He had been chronically ill for six months with enlargement of the abdomen and cough when the left foot and lower part of the left leg became blue, swollen and tender. Gradually this gangrenous area became deep black and was separated from the living tissue (Fig 6). Four months after the onset, when the soft parts had sloughed through to bone, an amputation was carried out through the thigh. The parts bled freely. The stump healed. Six months later the boy was still alive, although the general tuberculosis was more advanced. A section taken through the main vessels in the amputated leg showed endarteritis, confined largely to the intima. One of the veins showed some evidence of canalization as if it had been thrombosed (Fig 9).

The fourth case, a boy of fourteen, had an indolent perforating ulcer on the ball of the great toe. In the course of three years he developed gangrene of the tip of the second toe and a perforating ulcer of the sole of the foot. The anterior portion of the foot was amputated. The stump healed soundly. The boy is well today and free from pain.

We have, then, four cases of gangrene in young subjects. The first and the second followed an acute general infection, in both of these the patches of dead tissue were multiple. The third occurred in a patient suffering from general tuberculosis with evidence of local endarteritis in the tissues above the

gangrenous leg, in the fourth local endarteritis was demonstrated in the foot, four or five inches from the gangrenous toe. The detailed report of three of these cases is given at the end of this paper, with the microscopical studies made by Doctor Shore of my staff, who has assisted me in its preparation.

In 1904, Bairaud¹ published a paper giving the records of 103 cases of gangrene of the extremities, occurring in patients under thirty and following acute infection. The occasion of this essay was an unusual instance of gan-

grene of both legs in a woman of twenty, following an infection of the finger. The autopsy showed an arterial thrombus from the aorta downward.

Among the cases he had collected, in forty-four the gangrene occurred in the course of typhoid and in eleven it followed typhus. In six the gangrene developed during measles, in five during scarlet fever, in two it followed diphtheria and in five pneumonia. In one case gangrene occurred after perityphlitis (appendicitis) in a six-year-old boy, in another, an eight-day-old infant, gangrene of both legs followed phlebitis of the umbilical vein. In still another,



FIG. 1

Case I. Gangrene of foot, and area over patella.

gangrene of the left leg, in a boy seventeen months old, was preceded by tonsillitis. Many of these cases are accompanied by autopsy reports or reports of examination of the large vessels after operation.

In 1914, Khautz² published a paper on "Spontaneous Gangrene of the Extremities in Children" and reported two cases, one in a child three years old, with gangrene of both feet and the lobes of both ears and a patch on the back of the hand. The gangrene was not preceded by any illness. Both legs were amputated, the patient recovered. No anatomical cause for the gangrene was found. The vessels appeared normal to the surgeon doing the amputation. No microscopical examination was made.

The second patient, a four-year-old boy, had gangrene of both feet. The

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gangrene was preceded by an illness, possibly measles Both feet sloughed off The child recovered

Khautz collected and published the records of fifty cases, thirty of these are the same as those reported by Barraud

Every year or two, during the last twenty-four, similar cases have been reported They are sufficiently uncommon to excite exceptional interest and are usually reported with the prefatory remark that the rarity of the condition has occasioned the publication and, for the most part, with reproductions of photographs showing the lesions Between 1914 and 1925, Gerlach,³ Veau and Weber,⁴ Hoyne,⁵ Hellstrom,⁶ Gunson,⁷ Robbins,⁸ Chodax,⁹ Michael,¹⁰ Frenkel,¹¹ Thorpe,¹² Kramer,¹³ Brusa,¹⁴ Gordon and Newman,¹⁵ Harrell,¹⁶ Hoopman,¹⁷ Perrier,¹⁸ and Learmonth,¹⁹ have all reported cases of gangrene in children, following infection

In looking back on the autopsy findings and the observations made on vessels of the amputated limbs in these reports, four groups can be distinguished (1) The gangrene has followed an

embolus, the primary thrombus being in the heart or the aorta, (2) there has been a primary thrombus in one of the large vessels supplying the extremity (3) there has been evidence of local arteritis in the vessels above the gangrenous area, (4) no change has been found in the vessels up to the line of demarcation, there has been, presumably, a capillary thrombosis which has passed on to massive tissue death

The gangrene has been preceded by acute general infection in so many instances in all groups that it seems probable that microorganisms or toxic substances liberated when microorganisms are growing in the body, are factors that cannot be set aside It is also obvious that some unusual circumstance or combination of circumstances has been added, for it is a matter of common knowledge that measles, scarlet fever, diphtheria, typhoid and typhus fever, all manner of acute general infections, run their course commonly without any such phenomena



FIG 2
Case I Gangrene of ear

The study, then, leads to a brief consideration of the occurrence of thrombosis under the influence of infection in the heart, in the large vessels, or in the capillaries of a given area

As Aschoff expresses it, using a mathematical figure of speech, thrombosis is the function of a number of variables. There are factors that have to do with injuries to the endothelial lining of the various parts of the vascular system, there are factors that have to do with slowing of the blood current and there are those which have to do with alterations in the makeup



FIG 3
Case I Five years later showing deformity of ear following separation of gangrenous tissue

of the blood. All these factors play a part but we are still ignorant of the order of their occurrence. Damage to endothelial cells by toxins, slowing of the current, deposition of fibrin, perhaps a few microorganisms caught in the fibrin meshes, further local destruction and the formation of a thrombus may in some instances be the sequence. The dominant factor may be on the other hand, a slowing of the blood current. The velocity of the flow may be reduced to a point where certain of the solid ingredients, like the blood platelets, settle out. It is even possible that the endothelium dies as the result of being covered over by platelets, as suggested by Aschoff,²⁰ and the institution of the changes leading to the separation of fibrin and the formation of clot may not be due in the first instance to damaged endothelium.

It must be remembered also that there are altered relations in the blood itself, brought about by infection, which may act as a promoting factor. The circulating blood has floating in it a number of formed particles with different specific gravity. There are changes, in infection, in the numbers of leucocytes and probably also in the numbers of blood platelets, and possibly in the agglutinating properties of the platelets. There is a suspension stability for the various ingredients of the blood. Fahraeus²¹ has shown that there is, at times, an increase of the globulins (fibrinogen) in the plasma during the reaction of the body to microorganisms.

Whatever the sequence of the factors may be, occasionally during the course of infection in children, not only are thrombi formed on the mitral

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and aortic valves, but also in the heart cavities, especially in the auricle, and in the large arteries and in the small arteries and capillaries

(1) When portions of a thrombus in the left heart or large vessels break off they are carried into the systemic circulation, forming emboli. Wherever an embolus lodges it becomes adherent and a secondary thrombus forms which extends peripherally, and to some extent centrally producing thus not only blocking of the main vessel but shutting off, to a large extent, collateral circulation. Consequently the probability of gangrene is far greater after an embolus than after ligation of a vessel, for the clot is then confined to the region of the ligature. These facts have been established not only at autopsy but by observations made by surgeons who have incised the large vessels and removed emboli and secondary thrombi from their interior. A paper by Einar Key,²² published in 1922, gives interesting details of forty-eight cases in which embolectomy had been performed. All such emboli, though they have a definite relation to infection, do not set up where they lodge the forms of purulent inflammation which we are accustomed

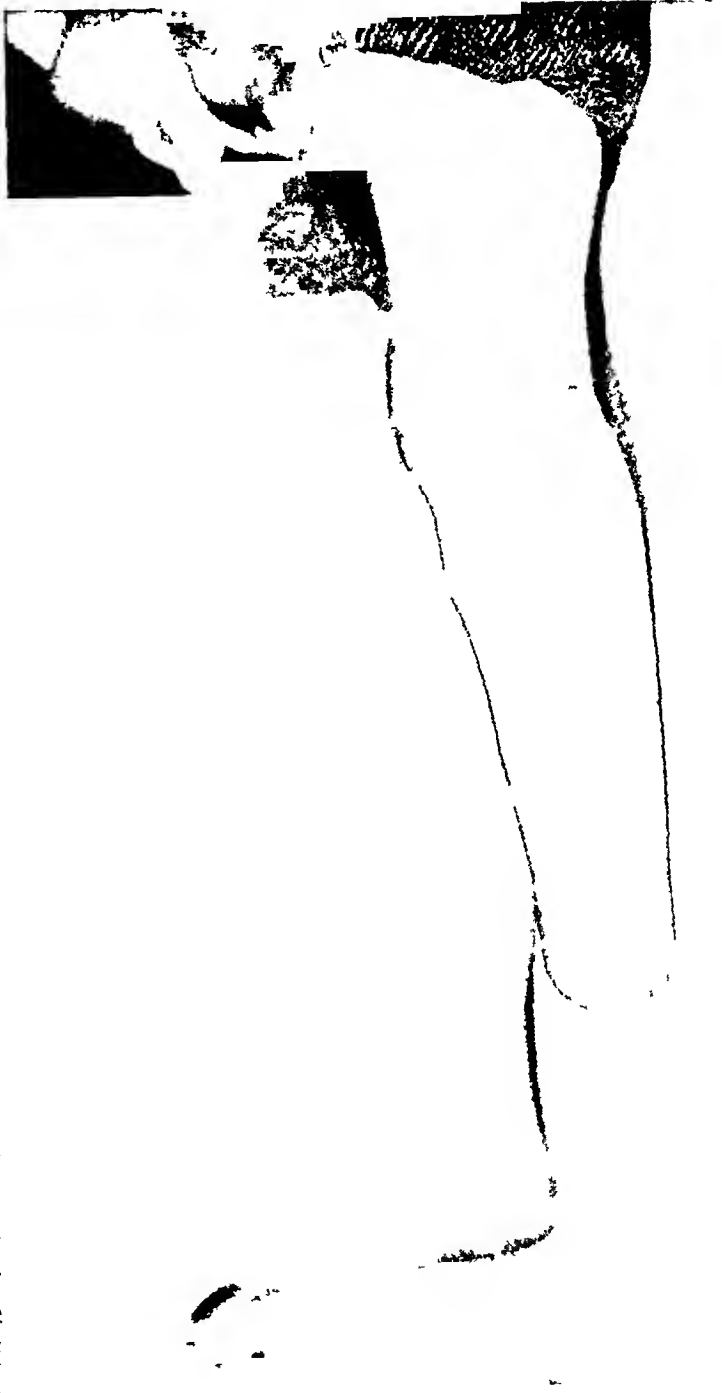


FIG. 4

Case I Five years after separation of gangrenous foot

to associate with septic emboli. Local tissue death, due to cutting off of the blood supply, is the clinical result. Many autopsies, in cases of gangrene of an extremity in children and even in symmetrical gangrene of the extremities, have demonstrated the primary thrombus in the heart and the embolus of emboli in the extremity vessels. An instance is reported by Bull,²³ who pub-

lished in 1922 a study of 6140 postmortem examinations with special reference to gangrene of the extremities

A boy twelve years old had gangrene in the left calf and the toes of the right foot. He had had, before the onset of actual gangrene, attacks of pain in both legs, numbness and cyanotic coloring. He died suddenly. At autopsy the abdominal aorta was completely thrombosed from about the level of the renal vein. The thrombosis could be traced downward through both common iliac arteries. The collateral circulation was not examined. On one aortic valve there was a large "polypous grayish-white excrescence", the other valve was normal. The relation to infection can also be seen in these autopsy reports, at least the autopsy records show both lesions of infection and thrombi in the heart. In a boy seven months old, with broncho-pneumonia and left sided empyema, the heart was large and at the apex of the right ventricle there was a firm thrombotic



FIG 5
Case II Showing gangrene of both legs and hand

polypus, somewhat loosely fixed to the trabeculae. In other instances the autopsy records showed a thrombus in the heart without valvular disease, hypertrophy, myocarditis or acute endocarditis. In a boy four years old, with general tuberculous infection, the heart is recorded as pale and flaccid. There was a thrombus three centimetres long in the left ventricle. In another, a boy twelve years old, with purulent arthritis of the knee, the heart was large, flaccid and pale, there were thrombi as large as peas in the right auricle. In still another, a boy eight years old, with acute osteomyelitis, the left ventricle was dilated, in the left auricle were brittle, crumbling thrombotic masses. In these cases, although no actual lesion of the heart was demonstrated, yet a thrombus formed which in most instances gave rise to emboli in the kidney, liver, brain, lungs and, once, in the arm.

In the case reported by Hellstrom (1c), the autopsy performed on a boy twelve years old showed at the apex of the left ventricular cavity a thrombotic mass adherent to the wall. In the aorta, four centimetres above the bifurcation, was a loose embolus two centimetres long which did not fill the lumen. In the right iliac there were a few small coagula. In the hypogastric artery (internal iliac) on both sides there were thrombi which completely blocked the lumen. The left femoral artery contained a few small clots, the right was filled with a partially organized thrombotic mass. He had been in the hospital suffering from a severe attack of diphtheria and had been given large doses of anti-diphtheritic serum. He showed signs of embolism and was operated on. At the time of operation the circulation had stopped in the right leg for at least thirty hours and in the left leg five hours. Both common iliac arteries were incised and thrombotic masses removed that extended as far as Poupart's ligament. The patient died the next day.

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Evidence is also presented by the case reported by Harrell (*1c*), of symmetrical gangrene of the legs following pneumonia. The line of demarcation was present in the middle third of each leg. Both legs were amputated above the knee. The child recovered. The pathological report states that there was embolic blocking of both popliteal arteries. The embolus in the right popliteal artery was lodged at the origin of the anterior tibial, that of the left popliteal was a little higher up, behind the knee.

There can be no question that in certain instances juvenile gangrene results from embolic blocking of the vessels and that such occurrence has a direct or indirect relation to infection.

(2) A primary thrombus of a large vessel of the extremity has also been demonstrated a number of times.

Frenkel (*1c*) reported two cases of spontaneous gangrene of the extremities in children. One child was two years old and the other five. Both had tuberculosis. The autopsy report in the second case showed, besides the lung lesion, an adherent thrombus in the left popliteal artery, close to the bifurcation. The microscopic examination of the arterial wall showed inflammatory changes which correspond to the picture of a toxic arteritis. He refers to similar cases in adults such as the one reported by Schutt²¹. In no case was there evidence of the characteristic lesions of tuberculosis in the arterial wall, nor could tubercle bacilli be discovered in the arterial wall or the embolus. An interesting observation reported



FIG 6
Case III Showing gangrene of foot and lower third of leg

by Vaquez,²² many years ago, though in an adult, is pertinent. A patient with advanced phthisis suddenly had an attack of pain in the left arm. The arm became cold and cyanotic. Pulsation ceased in the brachial and axillary artery. The patient died six days after the onset of pain. The autopsy showed lung tuberculosis with a large cavity. The heart was normal. The left subclavian was blocked by a thrombus adherent to the posterior wall, the lesion presented none of the characteristics of tuberculosis but streptococci were found in the walls of the vessel. The source of the streptococci was assumed to be the secondarily infected tuberculous cavity in the lung. The thrombus had formed in a tuberculous subject as a result of arteritis due to streptococci.

It is well recognized that without an autopsy and even in some instances with an autopsy, it is difficult to distinguish between a local thrombosis and

an embolus with secondary thrombosis. The entire primary thrombus may be swept away by the rapidly flowing current and no trace of its origin can be discovered. Well recognized pulmonary emboli have been repeatedly demonstrated at autopsy and yet no thrombus discovered as a source of the embolism. In several of the cases reported, which have been observed carefully, no conclusion can be positively drawn as to whether an autochthonous thrombus or an embolus with secondary thrombosis is the cause of the gangrene.



FIG 7 (Marcus Experiment 17)
Symmetrical gangrene produced by infection and local injection
of adrenalin

A case in point is one reported by Chodan (1c), of chorea complicated by gangrene of the fingers. A girl, aged twelve, had had chorea for one week when she entered the hospital. It was a first attack. There was no history of rheumatism and no history of shock or overwork. Two years previously she had had diphtheria and a bad attack of tonsillitis during convalescence. It was a moderately severe attack of chorea. There was a soft blowing murmur at the apex. Ten days later the right hand began to grow white and the finger nails blue. It was fully a week before gangrene of the finger and ball of the thumb set in. There was no pulse at the wrist. The pain gradually became very severe, the systolic murmur became much louder. The brachial artery could be felt like a cord along the arm. It is interesting to note that

although the brachial artery was blocked, gangrene of portions of two fingers was the sole evidence of tissue death.

The explanation of the formation of a primary thrombus in an artery depends on the same factors as those already mentioned. The thrombus is found adherent to a portion of the arterial wall in which there is local damage to the endothelium. The conspicuous clinical feature is again the death of tissue distal to the blocked vessel, not inflammatory phenomena set up at the site of the thrombus.

It is difficult to think of such local action on the endothelium being produced solely by circulating toxins, although diffuse changes have been repeatedly demonstrated experimentally.^{25 27}

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In several instances microparasites have been demonstrated in the walls of vessels. From the phenomena presented they must be of low virulence or deposited in a refractory subject after an altered reaction has been established in long-standing infection. It is difficult to imagine sufficient slowing in the rapidly moving arterial current to let the platelets settle out sufficiently to initiate fibrin formation and coagulation or to enable contact with the endothelium long enough to have the cells take up microorganisms. An explanation often given is that the local endothelial damage which originates the thrombus is set up by changes in the nutrient vessels of the arterial wall. There is probably the same difference in velocity between the flow in the

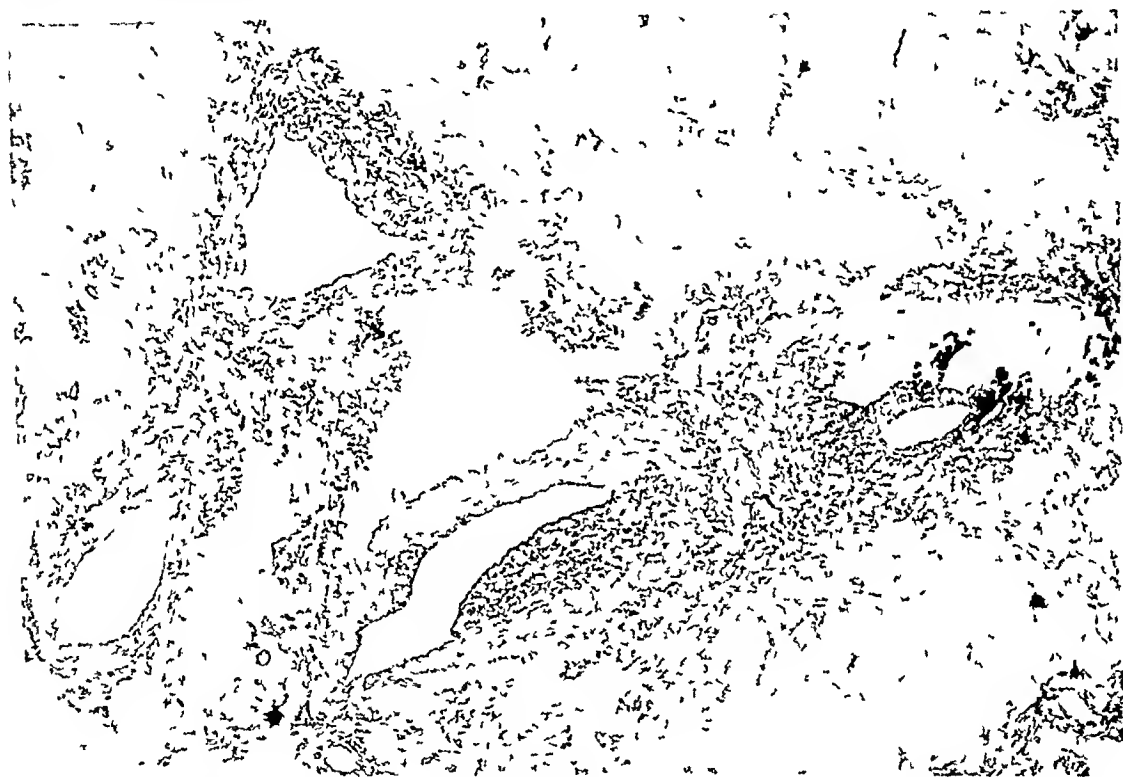


FIG 8—R A. Photomicrograph of the popliteal artery and accompanying veins, showing the fibrous tissue proliferation of the intima with a reduction in size of the lumen. $\times 20$ Case III

capillaries, into which these nutrient arteries break up in the vessel wall, and the main arterial current that there is elsewhere. The rate of flow, as given in physiologies, is sixty to 120 times slower in the capillaries than in the large arteries.²⁸

The anatomies give little information regarding the vasa vasorum. Porrier,²⁹ in the volume on the blood-vessels, has only a very brief statement. In 1922, Ostrogorski published in Russian a monograph on "The Nutritive Blood Supply of the Main Arteries of the Extremities." An abstract of his paper was given in German in 1923.³⁰ Ostrogorski examined seventy-six arterial stems. The femoral, the popliteal, the tibial, the brachial, the ulnar and the radial arteries were all studied by means of difficult and elaborate methods of injection and staining (Gerota, Teichmann). Most of the vasa vasorum spring from the small branches supplying the neighboring muscle

The immediate branching of small nutrient vessels from the main vessel is rarely observed. The slender vessels follow, for a time, the arterial stem which they nourish, then pierce the adventitia and gradually lose their identity in the muscular walls. They nourish the adventitia and the tunica media. The intima, under normal circumstances, contains no vasa vasorum. The angle of entrance is usually obtuse, rarely retrograde. Some of the minute vessels break up shortly after they are given off into a number of fine branches. All run parallel to the arterial trunk and the parallel branches anastomose freely with one another.

The number of separate branches is not the same for all arteries. There are zones of poor vascularity in the vessel walls.

The succession of events is, possibly, alteration in the endothelium and thrombosis of the minute capillaries of the arterial wall where the circulation is slow and the time of contact of the toxic agent prolonged, then local arteritis resulting in gross damage to the endothelium of the vessel itself.



FIG 9—R A Photomicrograph of a higher magnification of one of the popliteal veins shown in Figure 8. The lumen is partially occluded by fibrous tissue which in places is canalized. $\times 60$

Blood platelets become adherent to this damaged area, there is a separation of fibrin, the formation of a small white primary thrombus, then a mixed thrombus and finally, a large red thrombus blocking the lumen of the vessel.

(3) In a very considerable number of extremities removed at operation, careful examination has demonstrated neither an embolus nor a thrombus in a large vessel. There is a local endarteritis with narrowing of the lumina in the vessels above the area of gangrene. Two of the cases I have reported show such lesions. The change in both instances are strikingly similar. It must be remembered that in both the process had been present for months before the parts were amputated. In both the essential lesions found at the time of amputation were endarteritis and endophlebitis. The intima was thickened by an increase in connective tissue. In some places, especially in the minute arterioles, this new tissue was almost sufficient to occlude the lumina. The endothelium was intact, there were no thrombi in the vessels in the area examined. In one vein there was evidence which might be interpreted as originally thrombosis with subsequent organization and canalization (v Cases III and IV).

There were somewhat similar findings in a case reported by Kramer (1c) in which there were irregularly-shaped and various-sized patches of discolora-

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tion on the upper and lower extremities and gangrene of the left foot. The patient was a child about eight years old. He had been ill one week when the gangrene began. Amputation was performed above the knee twenty-four days later. Nine sections were taken from different areas in the amputated limb. They showed varied lesions in the vessels. The large arteries showed thickening of the media. At one point one large artery showed what appeared to be a very early and slightly marked necrosis. Opposite this was a thrombus firmly attached to the intima. The endothelial coats at this point had been lost. In all the sections the small arteries showed a thickening of the media resulting in a narrowing of the lumina to about one-third or more of their diameter. No thrombi were found in these vessels.

There can be little question of a group of cases of juvenile gangrene due to widespread changes in the walls of the smaller vessels. There is here, again, some connection with infection. Kramer assumed a relation with strains of streptococci, the portal of entry being the throat. The clinical signs that arrested attention were gangrene, trophic disturbance and purpura.

It seems from the last case I have reported that a localized endarteritis may occur in young subjects which is so subacute that the symptoms escape attention. There is no extensive thrombosis or gangrene until injury or infection occurs in the area which is poorly supplied by blood through narrowing of the lumina of the vessels. This form may represent an instance of mild infection of the small vessels of the same order as is seen in the severe instances with subsequent gangrene.

Experimental work has shown that when the intima is damaged by toxins or by microorganisms the damage is most marked in the capillaries and smaller vessels. That is to say, both toxins and microorganisms seem to produce most damage to the endothelium of the vessel walls when contact is most prolonged. The damage to the smaller arterioles is proportionally much greater than in the larger in the fourth case report (v. Fig. 13).

(4) Finally, there are cases of gangrene where no embolism of a vessel nor autochthonous thrombus nor arteritis has been demonstrated at autopsy or in an amputated limb. A striking instance is the case reported by Hoyne (1c) in 1915.



FIG. 10.—R. A. Photomicrograph of a higher magnification of the popliteal artery shown in Figure 8. There is a marked proliferation of the fibrous tissue of the intima with a great reduction in size of the lumen. $\times 60$

The child was five years old and died of broncho-pneumonia. He had, while in the hospital, scarlet fever, measles, double otitis media, swelling of the parotid, varicella and whooping cough. About 8 A.M., the forty-sixth day after the onset of scarlet fever, the thirtieth day after the onset of measles, the ninth day after the varicella and the seventh day after the beginning of whooping cough, large patches of a bluish-black hue appeared on the dorsum of the feet, near the base of the toes and smaller patches on the back of the right wrist and right cheek. By the evening of the same day the patches had enlarged and the lower half of the right leg was involved. The same day an area developed on the left cheek. All the areas were sharply defined and extremely painful. The skin above the cyanotic areas on all four extremities had a swollen, tense, waxy appearance. It looked oedematous but was rather hard, did not pit and was very painful. By the second day both ears were discolored over the upper half and became black and cold. The lower extremities began to look gangrenous but there was no extension of the process. Two fingers of the left hand and three on the right were also affected. On the third day examination of the chest showed a broncho-pneumonia and the temperature was 103° F. On the fourteenth day the child died as a direct result of pneumonia.

The autopsy, performed by Prof. Gideon Wells, showed that the thymus was smaller than normal and that the thyroid was somewhat enlarged and succulent, the heart was normal in size, there were no changes seen in the aorta and the valves were normal. The lower lobes and the lower half of the upper lobes of the lungs were consolidated. The kidneys were very pale, somewhat firmer than normal. The adrenals were enlarged. The vessels of the lower extremities showed no evidence of thrombosis or embolism. The right femoral

vein showed a large ante-mortem clot believed to be secondary to the gangrene and of recent formation.

Histologic examination gave no definite findings which could throw light on the etiology of the gangrene. Bacteriologic examination was made. Cultures taken from the



FIG. 11.—X ray of bones of stump taken two years after amputation. Case IV.

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thrombus of the right femoral vein showed a green streptococcus and a hemolytic streptococcus. Injected into rabbits, these caused a malignant endocarditis.

In a number of instances in which the patients have recovered, the gangrenous area of extremity has sloughed off and there has been no specimen obtained by amputation through living tissue well above the gangrenous area which could be examined and studied. However, it is difficult in these cases to believe that embolism or an autochthonous thrombus in a large vessel is the source of the gangrene. For example, the blood is supplied to the circular

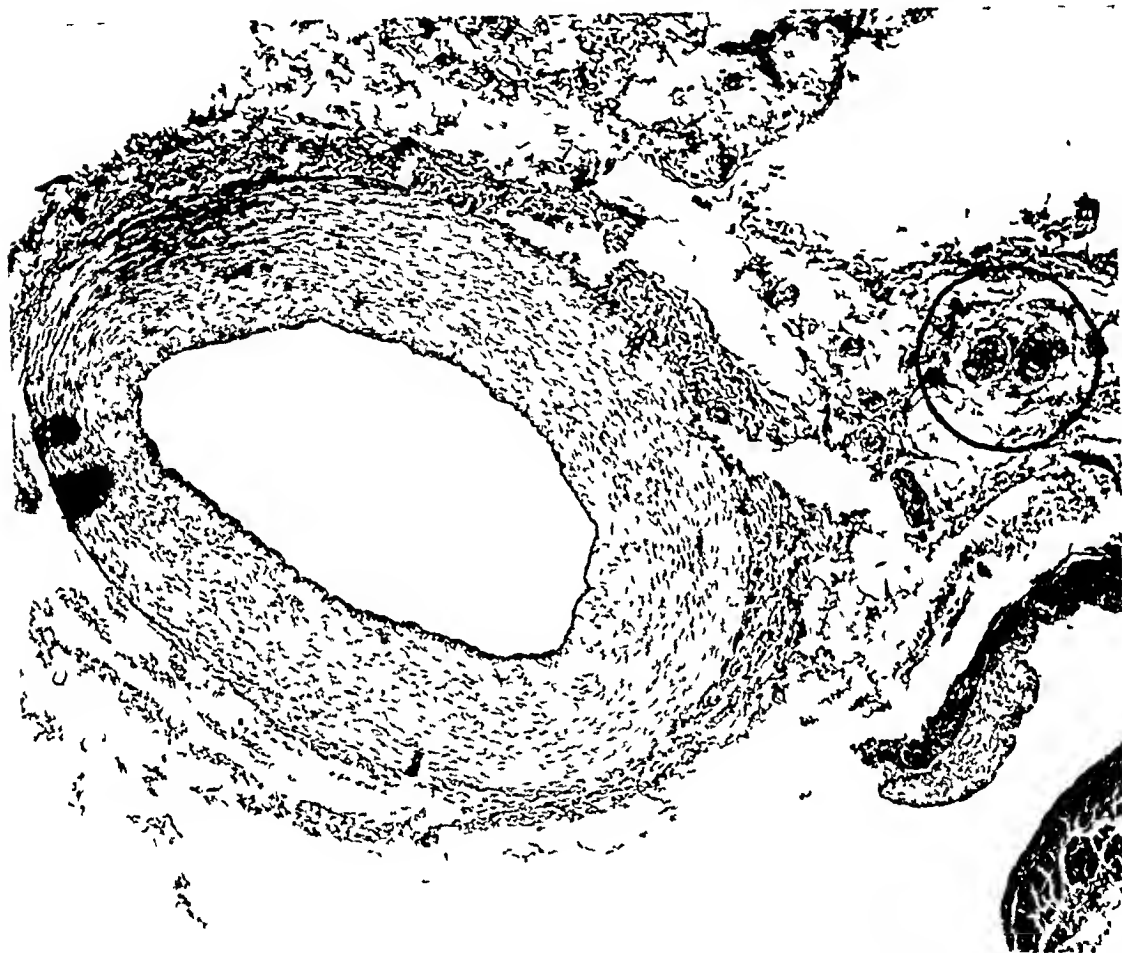


FIG. 12—I B. Photomicrograph of the plantar artery showing thickening of the intima. The partially occluded arteriole and venule in the circle are shown with greater magnification in Figure 13 x 30. Case IV.

skin area over the knee through a number of anastomosing small arteries. It is difficult to think of this area being shut off except by capillary thrombosis, yet there was gangrene in this area in the first case that I have reported. The same is true of the blood supply of the external ear.

In the case reported by Brusa (*loc.*) of symmetrical gangrene of the hands in a child of fourteen months, it is again difficult to think of double embolic blocking of the brachial arteries producing the lesions, and the same may be said for the second case I have reported. In Brusa's case the gangrene was apparently not preceded by an acute infectious disease. In the beginning of November the child began to complain at night, was excited and rubbed the hands together as if they were irritated. It was noticed that they were oedematous and livid. There was a slight fever. The feet were involved in

the same way. The color of the skin was dark, especially over the great toe. The skin of the extremities showed marbling, clear areas alternating with purplish. Finally, along a line one and a half centimetres above the fold of the wrist, one saw a zone of demarcation appear. This line was several millimetres wide and festooned. The hands became oedematous, large blebs full of sero-sanguineous fluid formed. The great toe turned black.

Von Pirquet and Wassermann tests were negative. The spinal fluid was normal.

One month and twelve days after the onset the left hand became detached and fifteen days later the right. A portion of the great toe also sloughed away. The general condition improved gradually and all the granulation wounds healed normally. It is interest-

ing to compare this case with Chodak's case (1c), in which only the tips of the fingers became gangrenous, yet the whole brachial artery was evidently blocked.

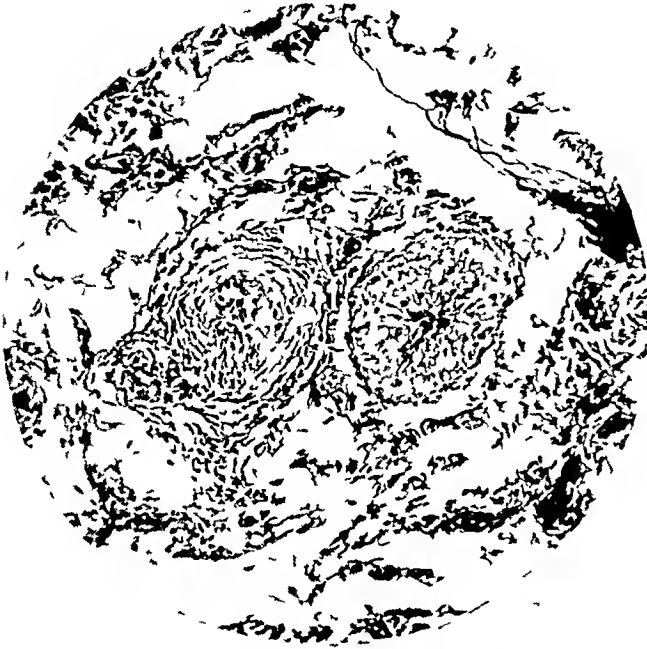


FIG. 13—J. B. Photomicrograph of the arteriole and venule included in the circle in Figure 12. It shows the marked proliferation of the intima with partial occlusions of the lumina. $\times 140$. Case IV.

ear not previously treated by adrenalin. In the ear in which the adrenalin had been injected there was local gangrene. Microscopical examination of the changes in the damaged ear, before the parts had become gangrenous, showed widespread hyaline thrombosis, damage to the lining endothelial cells and round cell infiltration about the capillaries and minute vessels. He varied the experiments in a number of interesting ways. He was not able to produce gangrene either by adrenalin alone or streptococci alone. His paper shows reproductions of photographs of fourteen rabbits with various forms of gangrene of the ear.

I have reproduced Figure 4 (experiment 17) showing symmetrical gangrene (Fig. 7). Adrenalin was injected subcutaneously in the left ear of the rabbit twice daily for eight days. There was no fever and no gangrene. Marcus then injected streptococci in the right ear intravenously. A lesion appeared in the left ear (that is, in the ear previously treated with adrenalin). He then repeated the streptococcal injection several times to produce a more

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long-standing infection. The right ear remained sound but injection into this ear of adrenalin caused a patch of gangrene. The introduction of adrenalin, which in itself produced no tissue death, so altered the resistance of the endothelium of the small vessels that subsequent injection of streptococci caused widespread capillary thrombosis and tissue death, and when a streptococcus infection was established the introduction of adrenalin produced enough change in time of contact or interference with nutrition to produce again hyaline thrombosis and gangrene.

We are all, I think, familiar with the curious local spasm of the vessels in the fingers called local syncope and local asphyxia. We have clinical evidence of a similar condition of spasm of the vessels of the hands and feet occurring in children.

The case reported by Lederer³² in 1914, is significant. A boy, six years old suddenly cried out with severe pain in the hands and feet. On undressing him the mother noticed that both hands and feet had become blue. The hands returned to normal in two hours but the change in color became more marked in the feet and the mother became alarmed and brought the child to the hospital. He had always been well, had had none of the infectious diseases, there was



FIG. 14.—J. B. Photomicrograph of a portion of the wall of a vein stained for elastic tissue. It shows the marked proliferation of fibrous tissue inside a poorly defined internal elastic lamella. A—Intima B—Media $\times 50$ Case IV

no history of syphilis or tuberculosis. Examination showed a well developed, strong child. There was a slight elevation of temperature. Both feet and the lower half of the legs were deeply cyanotic. The alteration in color was sharply defined. The legs and feet were very sensitive, cold and œdematous. After several hours the legs and feet became warm again and gradually resumed a normal appearance. Two days later the left hand suddenly became cyanotic and œdematous. The fingers were cold to the touch. Again there was a sharp line of demarcation. The pulse of the left radial artery seemed weaker than that of the right. This condition lasted five hours, then the parts returned to normal. The next day both feet were affected. The attack lasted three hours. Two days later both feet became cyanotic and cold and extremely painful. The child lay with the legs drawn up. The attack lasted two hours. The parts then returned to normal, the attacks ceased and no gangrene developed.

It must be remembered that Raynaud's thesis was written in 1862.³³ His admirable article, covering the whole subject of gangrene, appeared in the *Nouveau Dictionnaire de Médecine et Chirurgie Pratiques* in 1872,³³ before there had been any widespread recognition of the startling induction made by

Pasteur that all infectious diseases were due to microorganisms. Have we not here a possible explanation of the third stage of Raynaud's disease? Infection is added to local spasm. This is the view expressed by Marcus (1c).

An instance of curious spasm of the vessels of the extremities is reported by Holsclow and Booth³⁴. An infant six weeks old was given by mistake seventeen minims of obstetrical pituitrin, administered in six doses between 10 P M and 12 30 A M. The hands and feet became a deep purplish color and very cold. There was a sharp line of demarcation. The distribution of

the lesions was curious, the right hand and half way up the forearm, the left hand, except the thumb, on the right foot the big toe and the second toe, almost the entire left foot. The child died the following day. A complete autopsy revealed nothing except that the arteries seemed small as if contracted.

The study of etiology brings up the question of treatment. Amputation, embolectomy and operations on the suprarenal have been suggested in the different forms.

For many of these

small patients high amputation has been advised. The surgeon has been influenced by the knowledge gained in treating gangrene in old people in which it is generally recognized that it is desirable to amputate well above the gangrenous area, through the thigh for gangrene of the foot for example. I believe this is unnecessary. If there is dry gangrene of the extremities, it seems to me a far better practice to let the dead soft parts separate and sever only the bones or tendons, refashioning subsequently if a poor stump results. My own observations and case history after case history, show stumps with good nutrition and vigorous healing almost down to the gangrenous area. The analogy drawn from senile gangrene is unsound. Protecting the area from injury, keeping the skin margin along the line of demarcation scrupulously clean, making every effort to avoid secondary infection of the granulating area and attention to the general health, are essential.

The question of removal of a portion of one of the suprarenals was brought into prominence by W. A. Oppel of Leningrad, in 1921³⁵. Such



FIG. 15.—J. B. Photomicrograph of a portion of the wall of an artery stained for elastic tissue. The proliferation of fibrous tissue which is rich in elastic fibres inside the internal elastic lamella is shown. A—Intima B—Media $\times 50$ Case IV.

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treatment could only have come in question in the fourth patient in my series. I give the abstract of the history of a similar case but in an older patient, reported by Leriche ¹⁶

A portion of the suprarenal was removed in a patient of thirty-two, who had trophic disturbances in the foot, pain contracture and a necrotic ulcer. Leriche had already amputated a toe and performed a periaarterial sympathectomy on the common iliac and femoral arteries a year before without relieving the symptoms. He reports the results as surprising. The pain disappeared instantly, the contracture and flexure disappeared, the ulcer cicatrized. Six months later he was still well and thoroughly satisfied with the success of the treatment.

The theory advanced by Oppel that certain forms of spontaneous gangrene are a consequence of the hyperfunction of the suprarenal and that this throws into the organism, in inflammatory diseases, an unusually large amount of adrenalin which produces spasm of the blood-vessels of the extremities and thereby also of the vasa vasorum resulting in interference with the nutrition of the vessel wall, is interesting. He has presented his views recently ¹⁷ and believes that the discussion has been settled theoretically and that a hyperadrenalemia actually exists in both spontaneous gangrene and in Raynaud's disease. These views have, by no manner of means, been universally accepted. It seems to me that the scientific evidence is as yet insufficient to furnish sound indications for the removal of a portion of the suprarenal in a case such as I have described. In all these discussions, as in the discussion of thrombosis we are evidently dealing with multiple factors. The cause is not simple or single, it is complex and multiple. The increased output of the suprarenal may be a contributing cause. But the permanent control of this excessive output by the removal of a portion of one gland seems to me unlikely.

In regard to embolectomy, the brilliant work of Einar Key stands out. He reported in 1922 the results in eight cases in which he had performed the operation. These operations, however, were performed for threatened gangrene, not for established gangrene and the patients were adults. I have reported the results in a boy of twelve operated on by Hellstrom. The difficulty of early diagnosis, the fact that the children for the most part have been very seriously ill from general infections and that a general anæsthesia would be necessary, that the vessels are small and that incision into the walls may well set up a widespread thrombosis, makes the procedure seem ill-advised in children.

To Summarize —Gangrene in children, even symmetrical gangrene, is not an entity.

Some of the cases are due to embolism, others are due to autochthonous thrombi, still others are due to endarteritis of the minute vessels and capillaries, and spasm of the vessel seems to play a part.

Nearly all the reported cases have occurred during the terminal stage or subsequent to a generalized infection.

Experiments on rabbits show that the minute vessels of the extremities

can be so altered by a combination of the local injection of adrenalin and the intravenous injection of small doses of streptococci that capillary thrombosis occurs, followed by gangrene

Both sequences occur, producing tissue death spasm, then infection and infection followed by spasm

There is a clinical record showing that spasm of the vessels, with a curious local distribution, may occur after the administration of pituitrin in an infant

The use of the term Raynaud's disease for all cases of symmetrical gangrene is misleading

CASE I—(Figs 1, 2, 3, 4) R N, a child four and a half years old, was referred to St Luke's Hospital, March 29, 1923. He was a well developed boy, appearing as if he had suffered and was still suffering from a severe illness. The physical examination was negative except for a systolic murmur heard over the apex of the heart and a to and fro pericardial friction rub heard over the aortic region and along the sternum and to the right of the sternum in the fourth interspace. The pulse was rapid and feeble. The temperature was 101° F. The left foot was coal black and cold. There was a sharp line of demarcation just above the ankle-joint. Above this there was a circular zone slightly reddened and suppurating where the beginning ulceration was separating the living from the dead tissue. The leg above was oedematous, over the patella was a similar circular gangrenous area about five centimetres in diameter. The right leg and foot were oedematous. There were several small areas on the right foot appearing as if they had recently healed after being denuded of epithelium. There was a bleb on the tip of the right middle finger. Two-thirds of the right external ear was cold and black, with a sharp line of demarcation separating the living and dead tissue. The outer margin of the left external ear showed a similar condition. Lips, teeth and mucous membrane of the mouth and tongue and pharynx were normal. The tonsils were moderately enlarged. There were no enlarged lymph-nodes.

The mother stated that the child had been taken suddenly ill three weeks before with difficulty in breathing and cough and a high temperature. He complained of pain all over and particularly when touched. He seemed to have difficulty in swallowing, vomited and complained of abdominal pain. The pain became more and more severe. The child had slept little and cried out from time to time.

After three days his general condition improved, he sat up in bed. At the end of a week his legs became extremely painful. An area over the left ankle and heel became bluish and a bleb formed. At the same time a similar area formed over the patella. Within a few hours the right ear became greatly swollen and turned purple. The following day similar changes took place in the left ear, but they were less marked. The penis became swollen and several blebs appeared on the prepuce.

The areas affected were all exquisitely painful and acutely sensitive to external impressions and all the lesions except that on the penis had passed to the condition of gangrene seen at present.

The child was one of twins and had always been well except for an attack of influenza with bronchitis two years previously. The family lived in a cold, damp house and the mother thought that the child on several occasions became seriously chilled. There was no history of freezing or frost bite of the ears or feet.

The mother was so excited by the nature of the illness and the feeling that portions of the child were dying under her eyes, that it was difficult to obtain a consecutive story of the illness, but the facts seem to have been as related. Wassermann reaction was negative.

The patient was referred to the medical service as the indications of pericarditis and endocarditis and the acute illness seemed to be the urgent features and the advice

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was given to protect the gangrenous areas from trauma and to keep the sulcus forming along the line of demarcation as clean as possible.

One by one the gangrenous areas separated. The foot sloughed through at the ankle-joint at the end of two months. Without any anæsthetic the ligamentous attachments which held the foot to the leg were severed. Except for this there was no surgical interference. After the dead tissue was detached the parts rapidly healed.

The specimen of the foot removed was hard, dry and black. The articular cartilage was partially absorbed. There was no sound tissue from which to take a section for microscopical study.

The skin sloughed through at a level with or even higher on the leg than the joint, so that a conical stump was expected and the mother was advised to bring the child back for removal of the bone ends and the fashioning of a sound stump.

Two and a half years later a small portion of the fibula was removed and the conical stump was revised. During this interval the boy had had measles, whooping cough and chicken pox. He was examined in March of this year, five years after the operation, and was a well grown and sturdy boy. The skin over the stump was movable and the nutrition excellent. The stump of the right ear showed no abnormality. The skin was white and the scar looked as if a portion of the ear had been severed by a surgical operation. The heart sounds were normal, there was no thrill or sign of hypertrophy.

CASE III—(Fig 6) R. A., a Syrian boy seven years old, was admitted to the Pediatric Division of St. Luke's Hospital in July, 1913. The child had been normal until six months before admission when a moderate, gradual enlargement of the abdomen was noticed and he began to cough. He had been in St. Mary's Hospital, suffering from these symptoms, for two months. Four days before admission the left foot and lower part of the left leg became blue, swollen and tender.

Physical examination showed a poorly developed and nourished boy, slightly cyanotic, the cervical, axillary and inguinal glands were slightly enlarged. Pulses were equal and regular. The tongue was covered with patches (called "stomatitis") but did not seem tender. Below the angle of the right scapula there was dulness and bronchial breathing, extending into the lower axilla. The heart showed no lesion. The abdomen was enlarged and the liver percussed to the sixth rib, the lower border being at the level of the umbilicus. The surface of the liver was firm and not nodular, the spleen was not felt. There was shifting dulness in the flanks.

The left foot and lower half of the left leg were blue, slightly swollen, tender and cold. The toes could not be moved. There was loss of sensation to touch and temperature. The foot was not sensitive to pain. The upper edge of the discolored area was sharply marked, although the color was lighter along this line. The knees were held in flexion and seemed painful on motion. The knee jerk was not obtained on this side. The right knee jerk was present. There was no Babinski, clonus or Kernig.

The urine was negative except for a very faint trace of albumin. Examination of the blood showed hæmoglobin 90 per cent, red blood cells 4,800,000, white blood cells 14,000, polymorphonuclears 78, lymphocytes 22. The morphology of the blood was normal. The blood culture on two occasions was negative. Nose and throat cultures were negative for diphtheria. For several months the daily temperature varied from 98° F to 102° F. The pulse varied from 120 to 140. The respirations averaged between 38 and 65. Soon after admission the patient's right chest was tapped and thin, straw-colored fluid was removed. This was repeated several times while he was in the hospital. The abdomen was also aspirated five times and clear, straw-colored fluid, with a specific gravity of 1020, removed. A guinea pig injected with this fluid was negative for tuberculosis. Analysis of the Syrian bread and flour for ergot was negative. Intradermal luetin test was negative. The foot gradually became darker and a more definite line of demarcation was present.

Four and a half months after admission the left leg was amputated about six centimetres above the knee joint by Dr. W. A. Downes. The wound healed without difficulty.

The macroscopical examination of the specimen showed a leg amputated above the condyle of the femur. The foot and lower third of the leg were completely dried, blackened and mummified. At the line of demarcation there was a separation of tissues as deep as the bone, except for two tendons posteriorly. An intermission was left between the healthy and the mummified skin three centimetres posteriorly, two centimetres mesially and two centimetres laterally. The line of separation began internally six centimetres above the malleolus and ran diagonally upward to eleven and five-tenths centimetres above the external malleolus. Normal skin had grown inward and practically covered the upper edge of the muscle. The end of the skin ran down almost as far as the bone.

Microscopical Examination—The one section of the vessels and nerves taken for microscopical study is presumably from the popliteal region as the remainder of the leg is mummified and was not dissected.

Artery—The lumen of the artery is reduced to about one-fourth of its original size by a marked proliferation of the sub-endothelial connective tissue. There is a vacuolization of many of the new cells and a round cell infiltration throughout. This new tissue contains several capillaries in which are seen partially degenerated red blood cells. The endothelium is everywhere intact and smooth. The internal elastic lamella is intact. The muscle fibres of the media show mild degenerative changes and a moderate round cell infiltration (Fig 10).

Veins—The three veins accompanying the artery show essentially the same lesions, varying only in degree. There is a sub-endothelial proliferation of connective tissue which in places shows degenerative changes. In one of the veins this proliferating tissue had bridged the lumen in several places, so as to divide it into multiple channels. These fibrous areas contain capillaries and many large mononuclear cells with hemosiderin pigment. The endothelial lining is intact. The adventitia and media show only a round cell infiltration (Figs 8 and 9).

Nerves—Cross-sections of the nerves show degeneration of the axis cylinders and a moderate amount of round cell infiltration.

Discussion—The vascular changes in this and the following case are essentially identical. An endarteritis and endophlebitis are the prominent lesions. The only added pathological change which is open for speculation in the present patient, is as to the exact process which preceded the canalization of one of the veins. An original thrombosis, with subsequent organization and canalization, is to be considered but the presence of sub-endothelial thickening in the other veins, identical except for the bridging of the lumen, is more in favor of an obliterating endophlebitis, without thrombosis. The proliferation of the sub-endothelial connective tissue and the diffuse round cell infiltration are the reactions expected following injury to tissues. The injury in this case may be infectious or toxic. There are no lesions in the amputated part which in any way resemble tubercles.

The boy was discharged improved from the hospital several weeks later, but returned in two and a half months, the abdomen being again swollen. The amputation stump was well healed, the right leg was thin, small, but showed no œdema. The abdomen was tapped several times and the patient was discharged after three months, slightly improved. One month later he was admitted to Bellevue Hospital. The records there showed that an exploratory laparotomy was performed. The peritoneum, intestines and liver were everywhere studded with firm, yellowish nodules, varying in size from the head of a pin to a hazel nut. The pathological report from sections removed at operation showed tuberculosis. The abdominal wound healed and the child was discharged from the hospital. He returned one month later showing a large swelling on the outer side of the left elbow. It had been opened several days before in the Out Patient Department and was discharging pus. The incision was enlarged under general anesthesia. Seven days later he was again discharged from the hospital with a diagnosis of tuberculous abscess of the left elbow. The records at Bellevue show no later admission, nor a notice of death.

CASE IV—J. B., a boy fourteen years old entered St. Luke's Hospital in Novem-

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ber, 1924 He had a discharging sinus on the ball of the great toe leading to dead bone A small, hard area had formed several weeks before and sloughed away, leaving a sinus The sinus had been twice everted

The physical examination showed a poorly nourished and poorly developed boy, but not appearing ill Except for enlarged tonsils and several bad teeth the examination was negative The heart and palpable blood-vessels seemed normal There was no disturbance of the sensory nerves The blood Wassermann was negative and the spinal fluid normal He gave no history of trauma, of undue exposure to cold or of acute illness His father and mother, one brother and three sisters were living and well The toe was amputated and the stump healed soundly

One year later he returned He had been well and free from pain until two weeks previously, when he noticed, on the dorsum of the second toe, a large bleb and that the nail had become loose and shortly after the toe had become swollen and red A conical portion of tissue sloughed out near the tip of the toe, leaving again a sinus leading to bone, exactly similar to the one seen on the great toe There was little or no pain associated with these changes

This toe was also amputated and healed promptly Although the vessels bled freely at both operations, they seemed smaller than normal The specimen showed the third phalanx nearly absent only the articular end being present The microscopical examination of the soft parts showed no evidence of tuberculosis or tumor and no prominent thrombosis There was much subacute inflammatory tissue lining a tract leading to necrotic bone

The next year when sixteen, the patient again came to the hospital He had been well and free from symptoms until two weeks before his admission He began, at that time to have dull pain (somewhat more acute after walking) in the ball of the foot and near the stump of the amputation of the great toe He had noticed a tender swelling in the left groin On examination there was a low grade cellulitis over the plantar surface of the foot, having its centre about a sinus situated a few centimetres behind the stump of the great toe An incision was made through this tissue down to the bone The wound did not heal The pain ceased, however except when the foot was injured the boy was able to work about a garage

At the end of another year a few drops of pus were still discharging daily through the sinus The dorsum of the foot was slightly swollen and somewhat sensitive The tissue about the sinus on the plantar surface was bluish the scanty pus discharging from the sinus was foul smelling, as if there was necrosis of the neighboring tissues There was a large gland in the groin Sedillot's modification of Pirigoff's amputation was performed, sawing through the os calcis obliquely and turning it up on the tibia, cut slantingly to correspond No tourniquet was used The vessels bled freely The skin was closed without drainage and the stump put up in a plaster-of-Paris bandage The wound healed by primary union He has now a strong, end-bearing stump in which the circulation seems normal The turned-up portion of the os calcis has united firmly to the tibia, partly by bone and partly by strong fibrous union There is no evidence of lessened calcium deposit in the terminal fragment (Fig 11) The boy uses an artificial foot When without the foot he walks about his room directly on the stump

Pathological Report—Macroscopical Examination The specimen consists of a left foot amputated at the ankle but not including the posterior half of the os calcis The great and second toes are missing, having been amputated at the metatarso-phalangeal joints The point of amputation of the second toe has healed over and is covered with thickened, desquamating epithelium On the ball of the foot, just behind the site of amputation of the great toe, is a half-moon shaped ulcer with a granulating base 2.5 cm in diameter The dissected dorsalis pedis artery shows a moderately thickened and white wall, but the lumen appears to be patent throughout The plantar artery is the same, except that the wall does not appear quite as thick

Microscopical Examination—Sections of the larger dorsal and plantar arteries of the amputated foot show the same histological changes. The predominating lesion is an endarteritis, as shown by a connective tissue thickening of the intima. In places this fibrous thickening of the intima is so great as to cause infoldings with a partial occlusion of the lumina. The endothelium is everywhere intact and smooth, and there is no evidence of thrombosis. The media is relatively thickened and in places shows a moderate amount of degeneration of the muscle fibres, recognized by patchy variations in staining. Stains for elastic tissue show the internal elastic lamellæ to be broken and frayed at irregular intervals. The adventitia shows no changes. Cellular infiltration of all the coats is lacking.

Arterioles—Sections of the arterioles show the same thickening of the intima as is seen in the larger vessels. In the smaller vessels, however, the new fibrous tissue of the intima is relatively greater as compared to the size of the vessel and in many of these the lumina are almost entirely obliterated. The degenerative changes, seen in the media of the larger arteries, are lacking in the arterioles.

Veins—The veins showed a marked thickening of the intima, due to new connective tissue. The media and adventitia are relatively normal. In the larger veins the thickened intima shows considerable myxomatous degeneration. The endothelium is everywhere intact and smooth and there is no evidence of thrombosis (Figs 12, 13, 14 and 15).

Nerves—Sections of the smaller nerve bundles show only minor and non-essential changes. The perineurium in places is slightly thickened and hyaline. Many of the fibres are surrounded by a small zone of œdema but degenerative changes of the fibres themselves are not seen.

Soft Tissues—The soft tissues show only slight pathological changes. In the region of the ulcerated area on the sole of the foot there is œdema of the connective tissue and a moderate degree of round cell infiltration.

In general it can be said that the essential lesions in this case are endarteritis and endophlebitis affecting the larger and smaller vessels alike. The intima is thickened by an increase in connective tissue and in some places, especially in the smaller arterioles, this new tissue is sufficient in amount to occlude almost completely the lumina. The endothelium is everywhere intact and there is no evidence of thrombosis.

Discussion—The endophlebitis and endarteritis in the amputated foot of this boy are in themselves believed to be sufficiently marked to constitute an adequate cause for the production of the gangrene when trauma or infection are added. While these vascular changes are the ones which are associated with both acute and chronic diseases the exact etiological factors in this particular case are not at all clear. A positive etiological diagnosis cannot be made and a tentative one can only be arrived at by a process of exclusion.

Clinically, thrombo-angitis obliterans or Buerger's disease can be eliminated by the age of the patient, his race, and the clinical history and course of the disease. By definition, thrombo-angitis obliterans is essentially a different process than the one which is seen in the arteries and veins of this boy. Both grossly and microscopically, thrombus formation is the essential lesion. In the acute stages the inflammatory reactions in the wall of the vessel harboring the thrombus are marked and characteristic. In the healed stage the vessel may be completely occluded by a thrombus, or the thrombus may be canalized so as to allow a diminished flow of blood. These changes are simulated in no way by the processes seen in the present case. Therefore, by clinical and histologic means, thrombo-angitis obliterans can be excluded as a pathological basis for the gangrene in the case under discussion.

The vascular changes due to congenital syphilis may be identical with those seen in this boy. At the same time, the histological changes seen are not characteristic and cannot be differentiated from the changes due to other acute or chronic infections. Therefore the proof for a diagnosis of syphilis must rest on the clinical criteria which in this case are entirely negative. The boy has none of the stigmata of congenital syph-

JUVENILE GANGRENE

his and there is nothing in the family history to suggest a syphilitic infection. He has a negative blood Wassermann which remains negative after a trial dose of neoarsphenamine. The luctin skin test is negative. The spinal fluid shows a normal cell count and globulin content and the Wassermann reaction is negative. With these negative serological tests and an entirely negative history as regards syphilitic infection of the patient or his parents, a diagnosis of congenital syphilis cannot be made.

Lastly, to be considered as etiological factors are the circulating toxic agents of the infectious diseases. The widespread and uniform distribution of the vascular lesions in the amputated foot of this patient strongly suggest a direct toxic injury to the intima. The repair of this injury with new fibrous tissue has been sufficient, in the smaller arterics at least, to almost occlude the lumina. Therefore, by the process of exclusion and in the absence of other more definite etiological factors, we are forced to conclude that the vascular changes, with the resulting gangrene of the toes, are probably dependent on the injury due to circulating toxins or microorganisms of past infections.

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NON-UNION OF FRACTURES

AN EXPERIMENTAL AND CLINICAL STUDY

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THE following observations present instructive information regarding the anatomical conditions found in non-union of fractures and the abnormal healing processes responsible for these conditions. The subject of non-union of fractures has been studied largely from the standpoint of surgical therapy.

When we examine the literature for causes of ununited fracture, we find a variety of conditions both general and local which have been considered etiologic factors. In fact it appears that any systemic disease which the patient may have had at the time of fracture has been deemed a cause of failure of union either through a specific toxin, as in syphilis or through deterioration of health, as in diabetes, nephritis, anæmia, or through dysfunction of the endocrine system with deficiency of calcium metabolism.

Of the local conditions assigned as causes of non-union we find defective innervation, disturbance of the blood supply of one or both fragments through injury to the nutrient artery, imperfect immobilization too perfect and prolonged immobilization, too great separation of the fragments, interposition of soft parts, infection with excessive suppuration, osteosclerosis of the ends of the fragments, tumors, lack of osteogenetic power and suspended vitality.

It soon became apparent in the study of our cases that all of the general and most of the local causes given as factors in the production of non-union could be ruled out, for in a series of forty-two cases of non-union all but two patients were robust, healthy men of middle age, who at the time of fracture were engaged in hard manual labor or were performing vigorous exercise. This agrees with the observations of surgeons in general, that failure of bony union following fracture occurs more often in the prime of life than at any other time.

The exceptions in our series were two—a boy, six years of age, who had had extensive suppuration following open reduction of a fracture of the radius, and a young woman, twenty-two years of age, with a moderately severe case of diabetes. In these two patients operations were performed and bony union occurred in the usual time.

There are two local conditions which all agree are important factors in the production of non-union. First, we know from clinical experience and from experimental study that the interposition of soft parts will cause non-union, and secondly, that wide separation of the fragments by the original wounding force, by gravity, by muscular contraction, or by loss of cortical

bone in compound fractures may be followed by fibrous union. The effect of gravity is best seen in fracture of the mid-portion of the shaft of the humerus in which the weight of the lower portion of the arm and forearm tends to separate the fragments. The effect of muscular contraction is observed in fracture of the patella, the olecranon process and in the avulsion of an apophysis in which cases fibrous union is the rule, if surgical reposition and fixation of the fragments are not secured.

As we occasionally see fracture of each of two-paired bones, followed by firm bony union in one and fibrous union in the other, or two or more fractures at different levels of the shaft of one bone in which all but one heal by bony union, it is reasonable to suppose that failure of osseous union is due to some local condition.

At the beginning of our study of ununited fracture it became evident that a clear conception of the histological processes occurring in the repair of a simple fracture was essential for the appreciation of the variations in these processes which give rise to non-union. It was also obvious that there was a decided lack of knowledge of the exact anatomical conditions present in cases of non-union.

It is known that the fragments are united by a bond of fibrous tissue, and as fibrous tissue is supposed to represent a stage through which the processes of repair of a fracture commonly pass, failure of ossification of the bond results in non-union. Just why ossification fails in these cases was not clear and the use of such expressions as lack of osteogenetic power and suspended vitality does not bring us any nearer the solution of the problem.

Bone possesses an extraordinary power of self-repair. This is not surprising when its mesoblastic origin is considered, for all mesoblastic tissues of the body possess unusual power of repair. It is a fact that osteogenesis does not progress at the same rate in all individuals nor in all bones of the same individual and it is easy to conceive that osteogenesis may differ in the same bone of an individual at different times.

But granting that the processes of repair are much more rapid in certain individuals than in others, and providing the various general and most of the local causes considered as factors in the production of non-union are absent, bony union ought to occur in a fracture of a long bone of a healthy animal in a reasonable time, unless there are some underlying anatomical conditions which prevent this.

In collaboration with Dr. Frank E. Blaisdell, the writer produced a series of simple fractures in kittens. By simple fracture is meant one in which there has been solution of continuity of the cortical bone without displacement of the fragments or with reposition of the fragments as near as possible to the normal position, and with a minimum amount of damage to the ends of the fragments and the surrounding soft parts, especially the periosteum.

Under ether anæsthesia the right humerus was bent across the thumb, in most instances the bone fracturing with an audible snap. The animals were sacrificed with chloroform at intervals of twelve hours to thirty-four days.

and the specimens studied radiographically, grossly and microscopically. Our observations included first, the immediate changes in the bone and surrounding soft parts which followed fracture and resulted from trauma, and secondly, the changes constituting the inflammatory reaction which result in a repair of fracture.

The different tissues of bone, namely the periosteum, cortical bone and medullary tissue were studied for the purpose of determining the precise rôle played by these in the reparative process. These tissues were also studied in animals of the same species at different ages and observations were made on the periosteum and cortical bone of children and adults during operation.

A study of these specimens shows the following: The periosteum of the growing bone of a young animal or child is a strong, thick, elastic and highly vascular membrane, firmly attached to the bone in the region of the epiphyseal lines, but elsewhere more loosely attached through the medium of a delicate areolar tissue, in the interstices of which are several layers of large cells, the osteal fibroblasts. The blood-vessels of the periosteum subdivide rapidly before entering the cortical bone. This vascular supply is most im-

portant. The membrane is easily stripped up from the cortical bone. If we compare this membrane with the periosteum in the adult human or experimental animal in which the bone has reached its maximum growth, we find that the latter membrane is relatively and often absolutely thinner, less elastic, less vascular and more firmly adherent to the cortical bone. Osteal fibroblasts may be present at intervals as a single layer, they may be difficult to find, or they are absent. Often the adult periosteal membrane is found to strip up from the cortical bone with difficulty and it may be found lacerated in part or in whole flush with the fracture line.



FIG 1—Transverse section of tibia of six months' human fetus showing A—Fibrous layer of periosteum B—Layers of osteal fibroblasts G—Cortical bone D—Haversian Canal with osteal fibroblasts depositing new bone

Examination of the cortical bone shows considerable variation in thickness and density in the human and experimental animals at different ages. The cortical bone of a young growing animal is thin, the haversian canals are large and filled with a delicate reticular tissue supporting blood-vessels. Along the walls of these canals many osteal fibroblasts are seen. In the adult, the cortical bone is thicker and more dense, the haversian canals relatively smaller

and the osteal fibroblasts are much less in evidence.

Bones of the young frequently bend and buckle and in experimental specimens from kittens, the lamellæ of the cortical bone are seen to slide on each other and the cortex bends fissures, or fragments. In the adult, the thick dense cortical bone often fractures in one plane or fragments much as a cast-iron rod breaks under strain. The medullary tissues vary with age. In the bone of the young growing animal the marrow is lymphoid and quite vascular and the bone trabeculæ are surrounded with one or more layers of osteal fibroblasts. In the adult animal the marrow is fatty, less vascular and osteal fibroblasts are fewer in number or often absent from the surface of the trabeculæ.

A study of our experimental

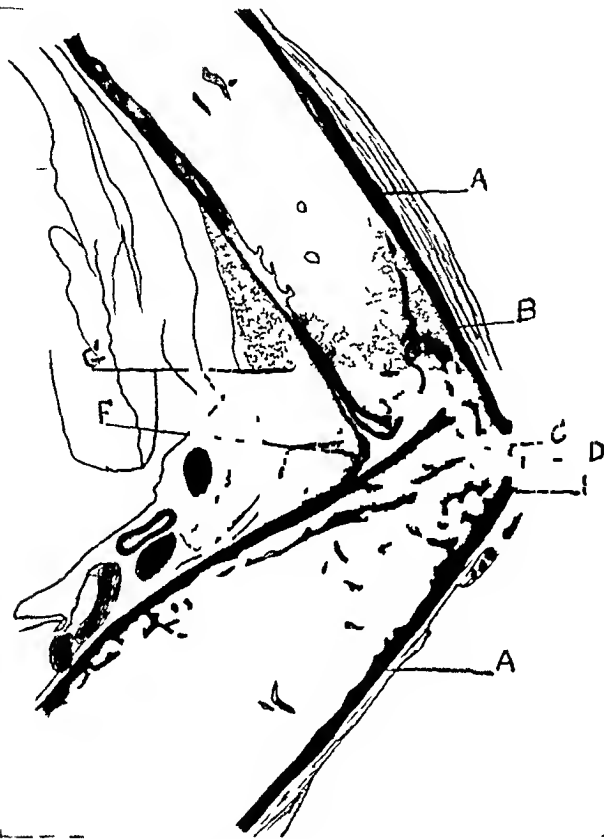


FIG. 2.—Camera lucida drawing of longitudinal section at site of fracture of humerus of kitten showing A—Cortical bone B—Periosteum, continuous on side of angulation and ruptured on opposite side, E C—Area of hemorrhage within medullary portion of bone D—Muscle drawn tightly over area of laceration of periosteum F—Periosteum and thin layer of cortical bone G—Area of hemorrhage external to periosteum

specimens at various stages of the reparative process of a simple fracture shows the following

With solution of the continuity of the cortical bone hæmorrhage occurs from the lacerated vessels of the periosteum, haversian canals of the cortical bone and the marrow. The blood extravasates, beneath the periosteum, about the fractured ends of the cortical bone and for varying distances into the medullary portion of each fragment. With laceration of the periosteum, blood finds its way into the surrounding soft parts. The extent of hæmorrhage will depend upon the vascularity of the periosteum and marrow and upon the amount of separation of the periosteum from the cortical bone, which determines the degree of resistance offered to suffusion.

Blood coagulates and seals the lacerated vessels. Fibrin is deposited

beneath the periosteum, about the ends of the fragments and in the medulla. Fibrin is a natural stimulus to fibroblastic proliferation. In these cases, when leukocytes are not present or when they are not attracted by injurious agents, fibrin is not dissolved and acts as a bridge between the fragments and exerts a specific attraction for fibroblasts. The cells begin to proliferate within a few hours, invade the fibrin mesh-work and rapidly replace it.

Fibroblastic proliferation is accompanied or probably preceded by the proliferation of vascular endothelium in the form of fine capillary buds. As early as the second day, end buds from the vessels of the periosteum and medulla can be observed about the periphery of the clot. These invade the clot and gradually replace it by a mass of vascular, oedematous granulation tissue consisting for the most part of anastomosing end buds and capillary loops, the procallus granulation tissue.

This procallus granulation tissue is well developed at the end of the first week, both in the medulla, where as fibrous marrow it has replaced the lymphoid marrow, and in the subperiosteal space. These procallus granulation masses fuse and reestablish vascular communication between the fragments.

Osteal fibroblasts which are numerous on the surface of the cortical bone, on the surface of the trabeculae and along the walls of the haversian canals in these young animals, proliferate along the vessels of the procallus granulation tissue, and osteoid material and cartilage are deposited. Ossification proceeds on the walls of the blood-vessels, and cylinders of new bone are laid down which later form the lamellae of the cortical bone and the trabeculae of the medulla.

It appears that pressure on the developing calluses plays an important part in the formation of cartilage. This pressure may be due to contact of the dense cortical bone with the medullary procallus granulations or to the overlying periosteum, which may be stretched and tense. The medullary procallus granulations often undergo ossification without an intermediate cartilaginous stage. In the specimens in which cartilage was present in the medulla of these bones there was always considerable lateral displacement of the fragments so that the cortical bone of one fragment lay in contact with the medulla of the other.

With the lifting up of the periosteum and the formation of blood clot in the subperiosteal and medullary areas, the cortical bone for varying distances on either side of the fracture line is deprived of its blood supply. Bone cells die and the lacunae rapidly become vacant.

Bone is different from all other tissue in having an abundant intercellular substance in which lime salts are deposited. If the bone cells are killed, this intercellular substance immediately becomes a foreign body which requires removal. The necrotic or dead cortical bone becomes irregular on its surface by cellular and vascular erosion and the haversian canals enlarged and irregular. As the haversian canals become enlarged and irregular in

outline, new bone is deposited on their walls, and this new bone is continuous on the external and internal surface of the cortex with the subperiosteal and medullary calluses. A sharp line of demarcation is clearly seen between the dead bone and the newly developed osseous callus.

Rarefaction of the dead bone continues and new bone is deposited until all of the dead bone has been replaced. With the restoration of function those portions of the subperiosteal and medullary calluses which lie outside the lines of pressure are gradually absorbed, while those portions of the calluses which lie within the lines of pressure are gradually thickened (Wolff's Law). As the medullary osseous callus disappears, the marrow again becomes lymphoid in character and healing is complete.

From these experiments it is seen that of the three tissues—periosteum, medullary tissue, and cortical bone—the periosteum is the most important. Leaving out of consideration the osteogenetic power of the periosteum, this tissue serves two very important functions in the healing of fractures: (1) without complete laceration, the periosteum serves as a bridge between the fragments which prevents their separation, and (2) it serves as a limiting membrane to confine the blood, and hence limit the clot in which the procallus granulation tissue develops.

Successful union is dependent upon the establishment of vascular communication between the procallus granulation tissue of the fragments. When contact of the fragments leaves no room for an appreciable clot, or what amounts to the same thing, when the apposition of the fragments is perfect, so that the clot is infinitesimal, healing by osseous union is almost certain to occur. Under these conditions, vascular communication is rapidly established between the fragments and healing may be said to occur *per primam*. This condition obtains in impacted fractures.

In all experimental specimens in which the periosteum remained intact but was lifted off the cortical bone, the subperiosteal callus appeared early and was the most important factor in healing by osseous union. In the cases in which the periosteum was lacerated flush with the fracture line, but was lifted up for a short distance on either fragment, subperiosteal callus developed, and resulted in an increase in the diameter of the end of the fragment. When the periosteum was retracted for a short distance from the fracture line, the end of the fragment became smaller by cellular and vascular erosion of the necrotic bone. When the periosteum remained adherent to the cortical bone at the line of fracture, no subperiosteal callus appeared, and the diameter of the end of the fragment remained unchanged.

Following a fracture with hæmorrhage into the medulla, the lymphoid marrow is rapidly replaced by fibrous marrow. This delicate, highly vascular and cedematous procallus granulation tissue is gradually replaced by osteoid and cartilaginous callus formed by osteal fibroblasts proliferating along the walls of the capillaries. Bone trabeculæ rapidly make their appearance along the inner surface of the cortical bone, bridge across the medul-

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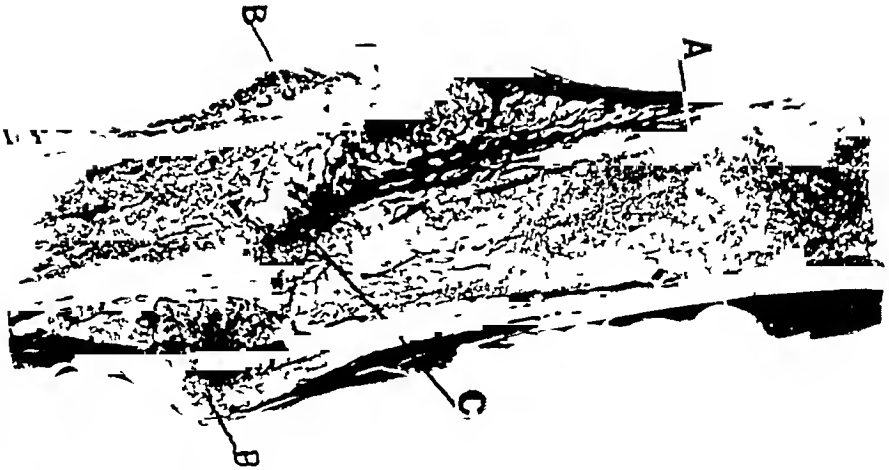


Fig. 3—Healing of fracture of humerus of kitten showing A—Original cortical bone B—Subperiosteal osseous callus C—Medullary osseous callus uniting fragments

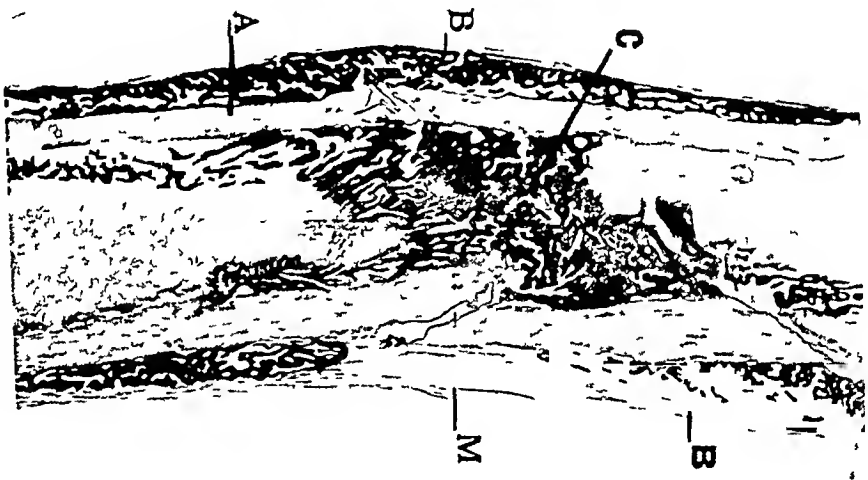


Fig. 4—Healing of experimentally produced fracture of humerus of kitten showing A—Original cortical bone B—Subperiosteal osseous callus C—Medullary osseous callus D—Marrow. Note—M, where the internal osseous callus has been lacerated, and has retracted the cortical bone, is covered with fibrous tissue and subperiosteal osseous callus is absent. Above and below M, where the periosteum has been lifted up from the cortical bone, subperiosteal osseous callus has formed which has increased the diameter of the bone at these levels.

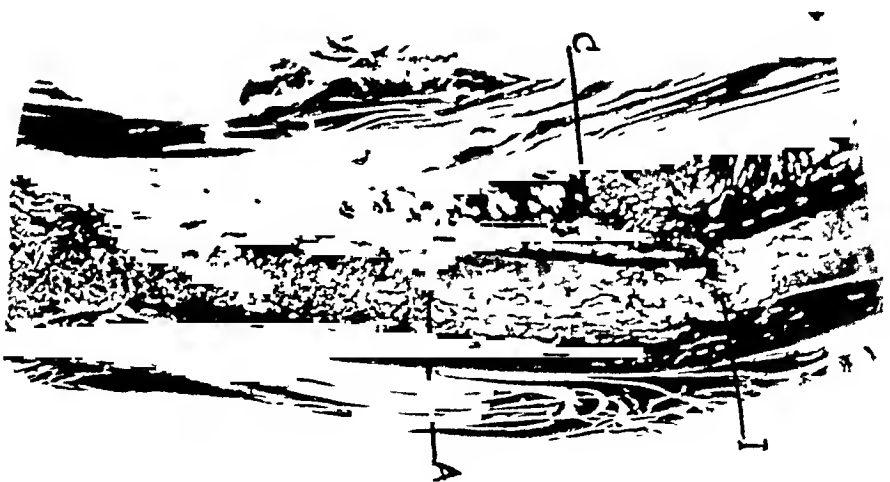


Fig. 5—Healing of experimentally produced fracture of humerus of kitten showing A—Original cortical bone B—Subperiosteal osseous callus C—Medullary osseous callus D—Marrow. Note—A, where the internal osseous callus has been lacerated, and has retracted the cortical bone, is covered with fibrous tissue and subperiosteal osseous callus is absent. Above and below A, where the periosteum has been lifted up from the cortical bone, subperiosteal osseous callus has formed which has increased the diameter of the bone at these levels.

lary space as the internal or medullary osseous callus and finally across the line of fracture, thus uniting the fragments. The medullary osseous callus is less in amount and slower in development than the subperiosteal callus and hence plays a rôle second in importance.

The cortical bone assumes a passive rôle in the healing process. Varying amounts of cortical bone on either side of the fracture line become

necrotic. Near the ends of the fragments, bone cells have disappeared, a little farther away they stain poorly and are undergoing autolysis. The surface of the necrotic bone becomes irregular from vascular and cellular erosion.

The circulation is reestablished rapidly by the ingrowth of new blood-vessels of the procallus granulations, the Haversian canals become enlarged and irregular. Osteal fibroblasts surrounding these vessels deposit new bone on the walls of the canals and a sharp line of demarcation between living and dead bone is clearly seen. This process continues until the dead bone is completely replaced. The so-called intermediate callus is absent and any callus between the cortical ends of the fragments develops from the subperiosteal or medullary calluses.

Having studied the processes of repair of a simple fracture which result in bony union, our next problem was to determine if possible the

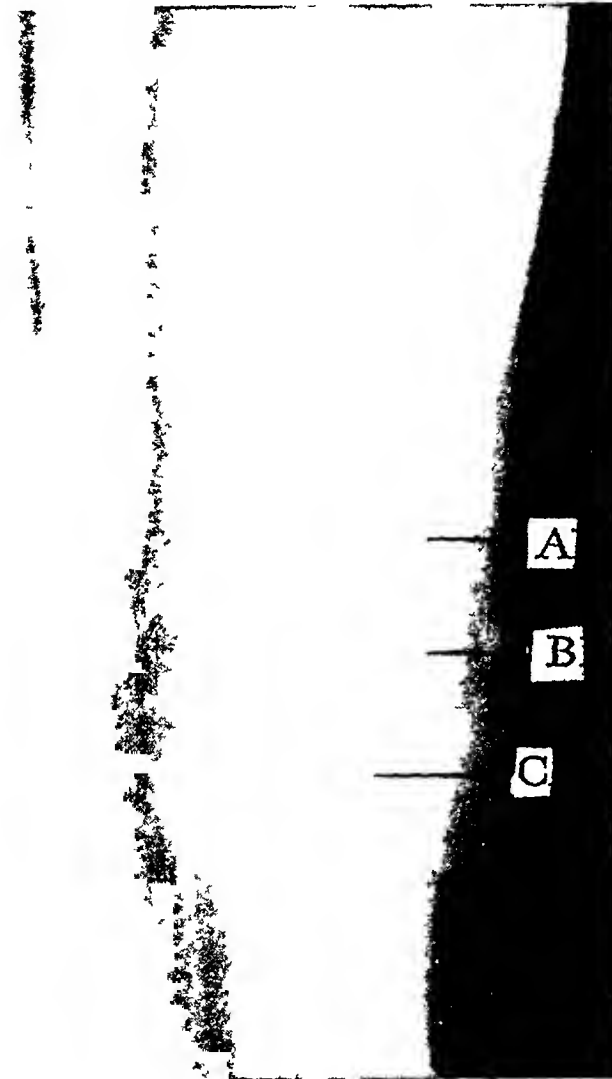


FIG. 6.—Radiogram of ununited fracture of tibia showing A—Thick cortical bone B—Subperiosteal osseous callus, and C—medullary callus forming bone buttress. Note increase in diameter of upper end of lower fragment.

variations in these processes which result in non-union and the causes of such variations.

To this end our studies included (1) radiographic examination of ununited fracture in the human, (2) examination of the ends of the fragments and the fibrous bond at operation, and microscopic study of specimens removed at operation, (3) the experimental production of non-union with microscopic examination of specimens and the comparison of these

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with cases from the human, (4) efforts to secure osseous union in cases of experimentally produced non-union and (5) the application of the knowledge thus gained to the surgical treatment of non-union in the human

Radiographic examinations of ununited fractures in the human showed a thick dense cortex, the development of a medullary osseous callus filling the ends of the fragments and forming a bone buttress, an increase in the diameter of the end of one or both fragments with an occasional isolated nodule of increased density in the fibrous bond, or a decrease in the end of one or rarely both fragments, or convexity of the end of one fragment, usually the upper, and concavity of the end of the other, usually the lower, with a cleft between the two

Observations of the fibrous bond at the time of operation, and



FIG. 7.—United fracture of tibia and fibula in human. T—Fibula fragments. Note increase in diameter of upper end of lower fragment. T—Tibial fragments with medullary osseous callus. H—Fibrous bond, the fibres of which are directed parallel to ends of fragment. L—Fibro cartilage being replaced by ingrowth of vessels from marrow spaces of tibial fragments. Note serrations of bone ends at L, and bone buttress above and below H in fibular fragments.

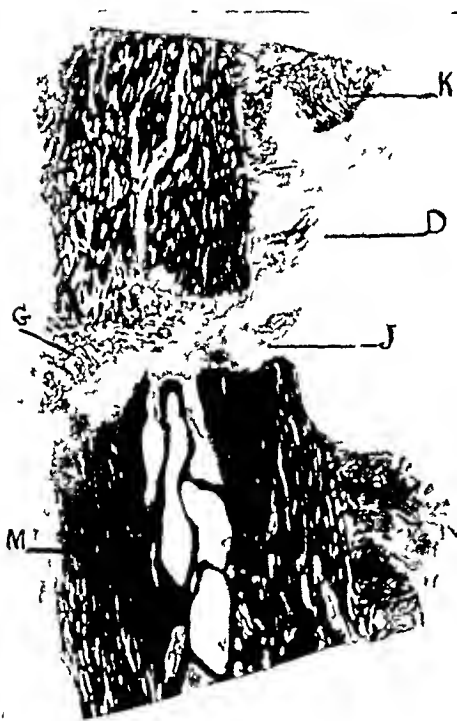


FIG. 8.—Ununited fracture of tibia in human showing. M—Thick dense cortex of fragment. J—Fibrous bond, the fibres of which lie in plane parallel to ends of fragments. G—New formed trabeculae of medullary procallus granulation. D—Dense fibrous tissue. K—Subperiosteal osseous callus. Note cortical bone beneath fibrous bond at J shows no new bone while further down the cortex of the lower fragment where the periosteum has been lifted up subperiosteal osseous callus is present.

histologic examination of tissue removed at operation showed three distinct types of non-osseous union (1) a firm fibrous union, (2) a loose fibrous union with or without clefts between bundles of dense collagen fibrils, and (3) a definite pseudarthrosis, with cartilage and synovial membrane

I Firm Fibrous Union—The fragments were usually in good alignment with slight separation. The ends of the fragments were either of normal diameter or more often one was of normal, the other of increased diameter, and the medullary portions were occupied by bone. In most instances a distinct bone buttress separated the marrow spaces from the fibrous bond, in others the surfaces were finely serrated and the marrow spaces were open. In this variety a fibrocartilage caps the ends of the fragments. The bond consists of a dense avascular fibrous tissue, the collagen bundles of which are directed for the most part parallel to the ends of the fragments

oi at right angles to the long axis of the bone. These fibres can be traced inward from the periosteum. The outermost fibres unite the periosteum of the fragments and run in a direction parallel to the long axis of the bone. Often there is enough bone production in each fragment to bridge the gap.

2 *Loose Fibrous Union*—In case of loose fibrous union the ends of the fragments present much the same appearance as cases of firm fibrous union with the exception that the ends of the fragments are serrated and a bone buttress separates the marrow spaces from the fibrous bond. The fibres of the dense avascular fibrous bond run largely in a direction parallel to the long axis of the fragments and are united to the bony serrations. In some specimens clefts appear in the fibrous tissue, the walls of which are quite irregular and the tissue is ragged and stains poorly.

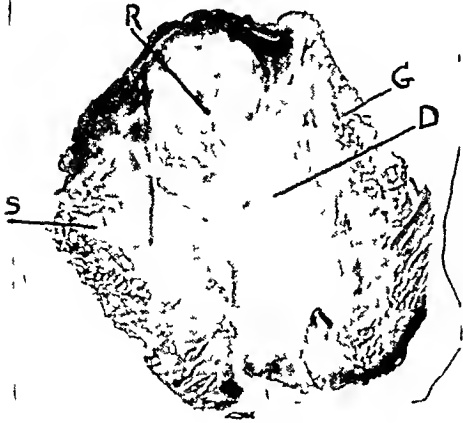


FIG 9—Ununited fracture of tibia in human with loose fibrous bond showing S—Fragment D—Fibrous bond, the fibres of which run for the most part parallel to the long axis of the fragments G—New bone formed from medullary procallus granulation tissue R—Island of new formed bone in fibrous bond

periphery, there often being more bone developed than is necessary to bridge the defect. The trabeculae of the ends of the fragments are considerably thickened, a bone buttress is formed and the apposing surfaces are covered with fibrocartilage. At the periphery the bones are united by fibrous tissue, which forms the capsule of the new joint. In some areas synovial membrane is present.

It was apparent from the examination of these specimens that there was one factor common to all and that was a separation of the fragments. The degree of separation varied from one-eighth to one-half inch or more. In transverse fracture of the mid-portion of the shaft of the humerus, the separation of the fragments was greatest. In oblique fractures of the tibia separation was of a less degree but was still apparent. *Separation of fragments can occur only by a stretching or*

3 *Pseudarthrosis*—In this case the apposing surfaces of the fragments are irregularly concavo-convex. The concavity is formed by growth of bone at the

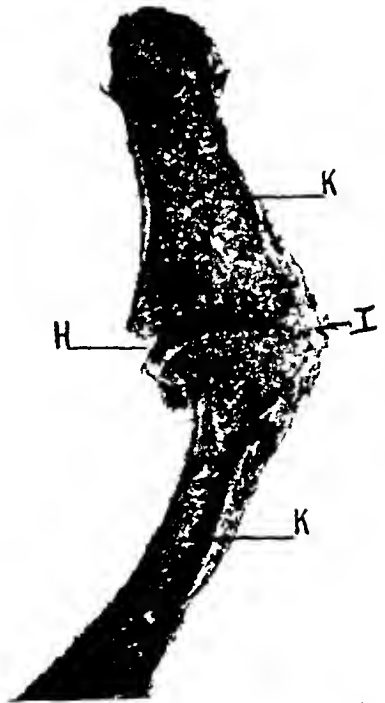


FIG 10—Pseudarthrosis of clavicle of human following fracture to show K—Fragments H—Joint space I—Capsule of new joint. Note concavo-convex outline of the joint surface and thickening of ends of fragments. There has been sufficient bone production to bridge the gap.

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laceration of the periosteum As the periosteum in adults is relatively thin and less elastic than in the young, it is more apt to tear than to stretch

Observations made during open reduction of fractures in which radiographic examination revealed a thick, dense cortical bone, with moderate separation of fragments, showed a complete laceration of the periosteum In several cases we were able to pass a probe between the fragments and demonstrate a complete absence of periosteal continuity In some instances laceration of the periosteum occurred flush with the line of fracture with or without slight retraction Where retraction occurred, the periosteum had been detached from the fragments for a slight distance on either side of the fracture line In other cases the periosteum had been stretched and detached from the cortical bone and ruptured on one or the other side of the fracture line so that the end of one fragment retained its periosteal sheath, while the other was denuded for a short distance

The importance of laceration of the periosteum and separation of the fragments is seen in fracture of the patella and olecranon Even with slight separation fibrous union is the rule in these cases and it is only after suture of the fibroperiosteum and the lateral aponeurotic expansions that bony union is most likely to occur

The separation of fragments results from (1) the original vuln-
erating force producing fracture, (2) gravity, as for example, the weight of the lower arm and forearm in cases of fracture of the mid-portion of the shaft of the humerus, and (3) muscle pull as in fracture of the patella and olecranon process Even the application of a Lane plate to the irregular surfaces of fragments may cause separation on the side opposite the plate It

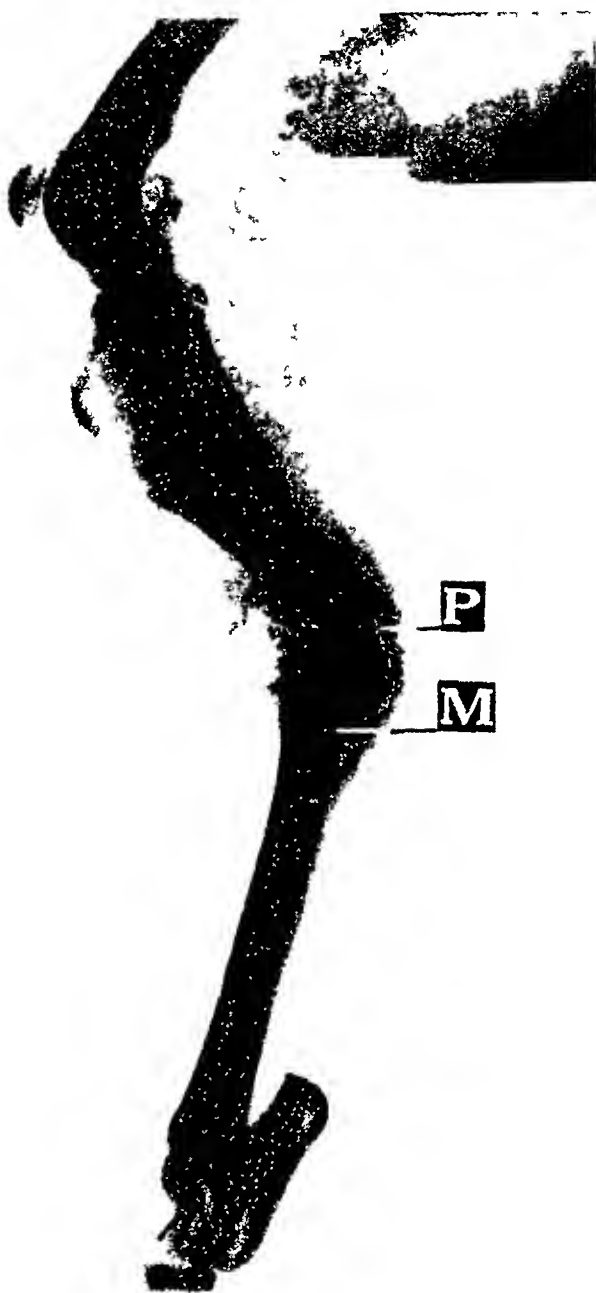


FIG 11—Experimentally produced ununited fracture of the tibia of dog P—Area of fibrous bond M—Upper end of lower fragment showing original cortical bone, and increased diameter of fragment in this area due to formation of new bone

was found that non-union was not uncommon after plating and the use of plates has been warned against by many writers

By producing solution of continuity of the cortical bone without lifting up the periosteum we sought to eliminate to a large extent the subperiosteal callus which we have seen is of such importance in the healing of simple fractures. Healing would then depend upon the more tardy and less abundant medullary callus. We therefore incised the periosteum of the mid-portion of the shaft of the tibia of the dog to avoid gross injury, especially to avoid lifting it off the cortical bone and then sawed through the latter with a fine saw. As there is a tibio-fibular synostosis in the dog, the fibula prevented separation of the tibial fragments and we secured bony union in some of our



FIG. 12—Experimentally produced ununited fracture in the tibia of dog showing A—Sclerosed ends of fragments and D—fibrous bond the fibres of which extend inward from the periosteum in a direction parallel to the surfaces of the fractured ends or at right angle to the long axis of fragments

specimens. With fracture of the fibula, however, the weight of the foot and lower portion of the leg was sufficient to cause separation of the fragments, even though the extremity was immobilized in a plaster spica well padded with sheet wadding.

We have seen that bony union requires the establishment of a vascular communication between the fragments, or a fusion of the procallus

granulations. As has been said the more accurate the apposition, the more certain is healing by osseous union to occur. If the fragments are not maintained in close apposition but are separated even slightly, the clot between the fragments is greater in amount and there is an additional factor in the reparative process tending to delay or even to stop completely bony healing. This is the ingrowth of granulation tissue from the periosteum. This harder connective tissue reacts to injury by proliferation, invades and organizes the clot between the fragments with greater rapidity than the more tardy granulations developing from the vessels of the marrow spaces. It forms a limiting membrane, which prevents fusion of the vessels of the medullary procallus granulations as effectively as an interposed piece of fascia or muscle.

The two types of granulations are easily distinguishable microscopically. That springing from the capillaries of the marrow spaces is delicate, highly vascular and oedematous, with fine collagen fibrils similar to the fibrous marrow from which it springs, while that growing in from the periosteum is

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dense, avascular with large bundles of collagen fibres compactly united like the fibrous periosteum from which it develops. At times the rate of growth of these two granulation masses appears to be about equal, so that a combination or intertwining of the two can be seen. Osteal fibroblasts from the marrow and haversian canals of the cortical bone proliferate along the capillaries of the medullary procallus granulations and form cartilage and bone. The final result of the reparative process will depend upon which of the two granulation masses gets the upper hand. If the medullary procallus granulation masses win, vascular communication between the fragments results, and bony union occurs. If there is a tie, irregular bony projections appear about the ends of the fragments and isolated nodules, or islands of bone develop in the fibrous bond, or union occurs over a portion of the extent of the fractured surfaces only. If the dense, avascular tissue from the periosteum gets the upper hand, it seems to choke the more delicate and vascular granulations from the marrow spaces and prevents their fusion in a manner analogous to that which occurs in a so-called amputation neuroma, in which we see the axis cylinders of the proximal segment of the injured nerve twisted and compressed in every direction. There appears to be sufficient growth of axons in the neuroma to bridge the defect, but they cannot get across.

Likewise in fracture, there seems to be no failure of osteogenesis in most of the specimens which have failed to unite by bony union, for long spurs of bone, more than sufficient to bridge the space, are often seen extending from one or both fragments. The ingrowth of dense fibrous tissue from the periosteum has acted as a limiting membrane to prevent fusion of the medullary granulations.

Coincidentally with the ingrowth of fibrous tissue from the periosteum, osteal fibroblasts proliferate along the vessels of the medullary procallus granulations and deposit bone which eventually plugs the medullary portion of each major fragment for a short distance from the end. In the earlier stages the junction of bone and fibrous bond is irregular, the bone ends are serrated and one sees active bone formation going on here with fibrous marrow between the serrations. Later we find a well marked bone buttress extending across the bone ends which separates and shuts off the marrow spaces from the fibrous bond. As the function of weight bearing is not resumed, because of instability, the medullary osseous callus does not disappear as in the healed fracture, but persists giving rise to the eburnated end of one or both fragments.

Where the periosteum is separated from the end of the fragment but remains as a sheath, a subperiosteal osseous callus forms which increases the diameter of the bone end. Where the end of the fragment is denuded, the outer layers of the bone become necrotic, granulation tissue surrounds it, the bone is gradually absorbed and becomes more or less conical in shape surrounded by scar tissue.

Function plays an important rôle in determining the type of non-union

In paired bones, such as the tibia and fibula or radius and ulna, where only one bone is fractured, but the fragments are not in contact, its fellow acts to prevent wide separation. Here the bundles of collagen fibres of the bond run for the most part parallel to the fractured surfaces. The same picture is seen in cases of fracture of the two bones where immobilization has

prevented separation or rather where tension has not tended to separate the fragments.

To demonstrate the effect of the absence of pressure and tension on the granulation tissue developing from the periosteum the following experiment was performed.

The anterior surface of the patella is covered by a thick fibroperiosteum. Beneath this the cortical bone is dense. If we drill a hole through half the thickness of the patella from the anterior surface, this becomes filled with dense fibrous tissue, continuous with the periosteum, the fibres of which run in a direction parallel to the long



FIG. 13.—Drill hole in anterior surface of patella of dog showing C—Patella D—Fibro periosteum and E—fibrous tissue in growth plugging hole. Note also bone buttress separating fibrous plug from marrow spaces.

axis of the hole. The more slowly developing granulations from the marrow spaces are prevented from fusing by this plug of dense fibrous tissue and new bone is deposited about the plug which forms a distinct wall. The arrangement of the cells and fibrils parallel to the long axis of the drill hole can best be explained by the absence of pressure and tension.

Where gravity or muscular contraction produces tension on the developing granulations the fibroblasts respond to this by the production of an abundance of fibrous tissue, the cells and fibres of which are arranged in the lines of tension and a fibrous bond similar in structure to a tendon is formed. We see this type of bond in cases of fracture of the patella and olecranon process, in which the fragments have been insecurely placed in position by suture or nail, but which have been separated gradually by muscle pull. In the dog this type is easily produced in the tibia by padding the plaster spica with sheet wadding. As the animal jumps about on three legs the lower fragment tends to be pulled away from the upper by gravity. In

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this type the uniting fibres run for the most part parallel to the long axis of the fragments, a buttress of bone separates the marrow spaces from the fibrous bond, the bone ends are more or less serrated and the uniting dense, avascular fibrous tissue bundles, tendon-like in structure, merge into the teeth of bone. This is observed in cases of non-union following fracture of the mid-portion of the humerus in the human, where the weight of the lower portion of the arm and forearm has gradually separated the fragments.

The difference between the medullary and periosteal types of granulations and the effect of tension during the developing of these is easily demonstrated experimentally in case of fracture of the patella. None of the ordinary methods used in holding the fragments of a fractured patella together are sufficient to prevent separation by the pull of the quadriceps extensor cruris muscle in experimental animals. If the patella is sawed transversely in its mid-portion and the fragments are

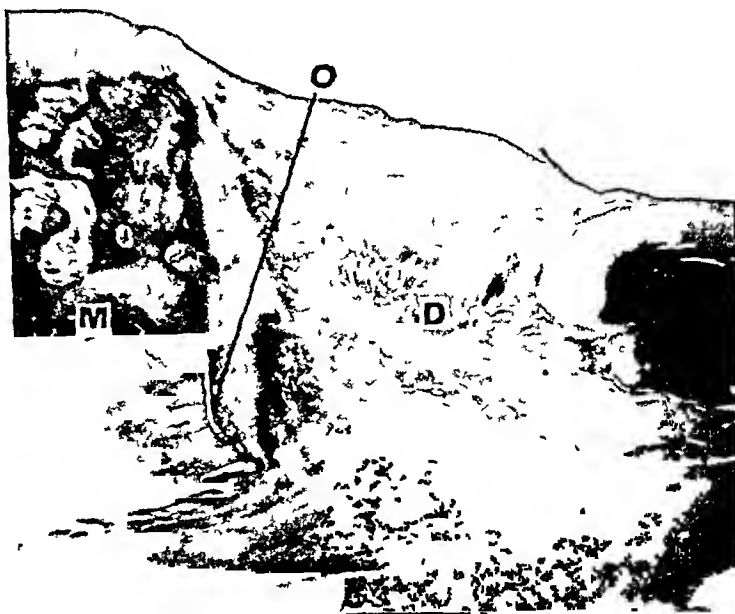


FIG 14—Experimentally produced fracture of patella of dog with suture of fibroperiosteum, separation of fragments by muscle pull. M—Fragment of patella. O—Medullary procallus granulation tissue, and D—dense fibrous tissue bond.

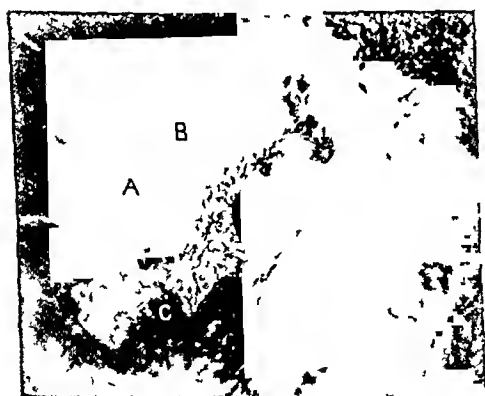


FIG 15—Fragment of experimentally produced fracture of the patella in dog showing A—Fragment B—New bone trabeculae developing in medullary procallus granulation tissue C

brought together by suture of the fibroperiosteum or by circular suture with wire, the steady pull of the muscles gradually separates the fragments, the sutures holding for a short time only. Granulation tissue develops from the marrow spaces of the patellar fragments. This is delicate, oedematous and highly vascular with fine collagen fibrils. Osteal fibroblasts from the marrow spaces invade this medullary procallus granulation tissue and produce bone trabeculae. Granulation tissue develops also from the periosteum.

This gives rise to a dense and much less vascular fibrous tissue which is similar to the tissue from which it springs. Because of tension the long axes of the trabeculae run parallel to the lines of tension so that the bone ends are serrated. The fibrous tissue developing from the periosteal granulations and uniting the fragments respond to tension by the formation of dense fibrous tissue, the fibroblasts and collagen bundles

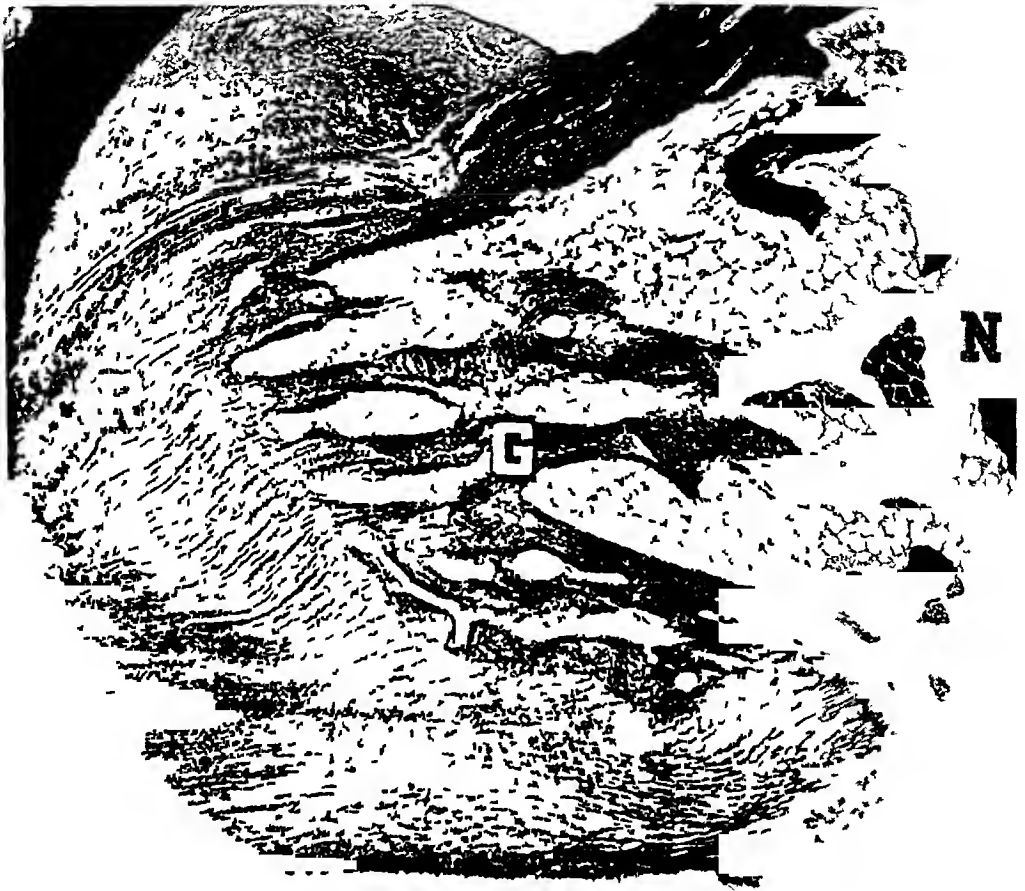


FIG 16—Fragment of experimentally produced fracture of dog showing N—Original fragment G—New bone trabeculae developed from medullary pro callus granulations R—Fibrous bond Note—Trabeculae and fibres of bond extend in direction parallel to lines of tension Serrations of end of fragment

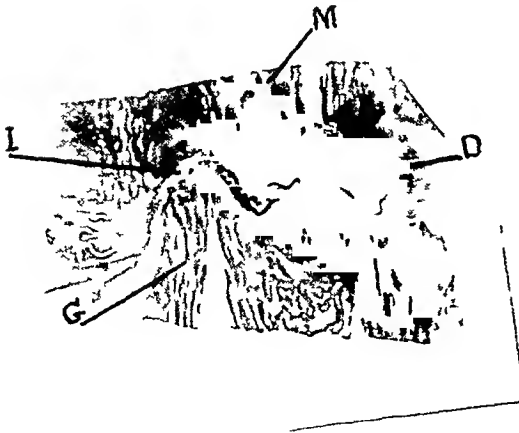


FIG 17—Old ununited fracture of tibia in the human showing M—Osseous medullary plug D—Fibrous bond I—Cleft in fibrous bond filled with debris the result of necrosis of the fibrous tissue of the bond due to pressure and motion



FIG 18—Experimentally produced pseudarthrosis in tibia of dog showing K—Upper fragment I—Fibrocartilage G—New bone developed from medullary pro callus granulations of lower fragment covered with cartilage and H—joint space

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of which are arranged in the lines of tension and form a strong tendon-like structure

In the third type of non-union there are irregular clefts in the fibrous bone or a well-defined joint cavity with cartilage capping the ends of the fragments. The fragments are end to end, end to side, or side to side, and the medullary portions of the ends are plugged with bone trabeculae. In some of the specimens the apposing surfaces of the fragments are quite irregular and serrated and one sees either bare bone or bone covered with necrotic and poorly-staining fibrous tissue. In other specimens the surfaces are irregular but smooth and in these there are areas of fibrocartilage undergoing ossification and areas in which the bone is irregular and serrated with fibrous tissue continuous with the serrations. In this type little motion is present due to the irregularities of the bone ends.

In other specimens a well-defined joint cavity is present between the apposing surfaces of the fragments. The end of the upper fragment is usually convex, while that of the lower fragment is concave. The concavity is formed by growth of bone at the periphery and in some specimens more bone has developed than is required to bridge the defect. In this type the medullary portion of the ends of the fragments is filled with bone trabeculae of the internal callus, a bone buttress extends across with fibrocartilage. At the periphery the fragments are united by fibrous tissue continuous with the periosteum, on the under surfaces of which a tissue resembling synovial membrane is seen. From the study of our experimental specimens the manner in which these different types of pseudarthrosis are formed appears to be as follows:

The fibrous bond having been formed and the medullary calluses having ossified, the limb is mobilized by the removal of the spica, and restoration of function, particularly weight bearing is resumed. This weight bearing causes the uniting fibrous tissue to be compressed. If, in addition, there are sliding movements between the fragments, the collagen bundles are separated, their fibres are ground and torn, and irregular slits or clefts with ragged walls appear. Continued compression causes necrosis of the fibrous tissue as is shown by its structureless appearance and staining reaction and the necrotic material is gradually absorbed or remains in the clefts as debris.

If mobilization and weight bearing or pressure occur after the fibrous bond has formed, but before the medullary calluses have completely ossified the medullary calluses of the ends of the fragments are transformed into fibrocartilage. Beneath the cartilage a bone buttress appears separating the new cartilage from the marrow spaces. In portions of the pseudarthrosis where there is motion without pressure we often find a tissue resembling synovial membrane. To show the effect of motion and pressure on the granulations developing from the marrow spaces the following experiment was performed. The patella is normally subjected to pressure as well as to tension. Its posterior surface is covered by articular cartilage. If a hole is drilled in the posterior surface of the patella through half its thickness

this fills rapidly with a delicate highly vascular granulation tissue from the marrow spaces which in this portion of the bone are numerous. Osteal fibroblasts from the marrow spaces grow out along the capillaries and deposit

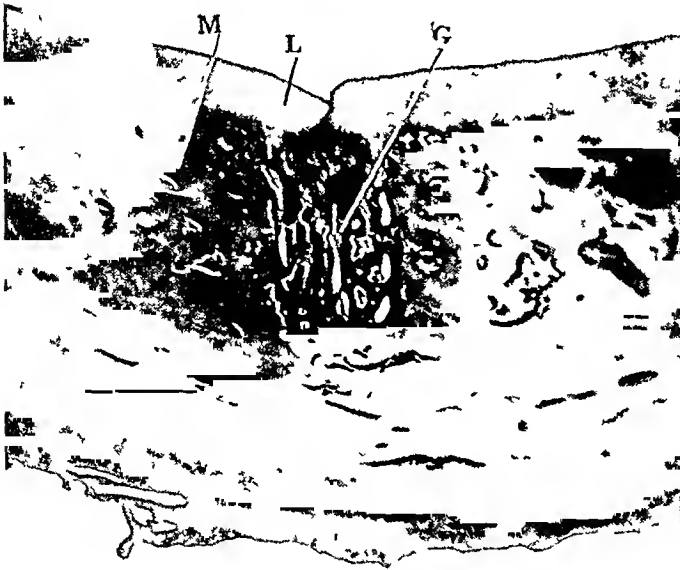


FIG 19.—Drill hole through posterior surface of patella of dog showing G—Hole filled with new bone, the trabeculae of which lie in lines of pressure L—New cartilage which has buckled because of the bending of the weakened patella through tension M—Original trabeculae of patella which lie for the most part in lines of tension

new bone, the trabeculae of which extend in lines parallel to the long axis of the hole. At the posterior surface of the hole where pressure is exerted on the medullary procallus granulation cartilage is formed.

That this new cartilage is not formed by proliferation of the surrounding preexisting articular cartilage was demonstrated by a series of three experiments performed by Dr Leonard W Ely and the writer, to determine the effect of injury

to the joint tissues of rabbits and to study the processes of repair in them and especially to observe the reaction and repair of articular cartilage.

(1) An incision was made in the cartilage of the patella and in the cartilage of the intercondylar groove of the femur.

(2) The cartilage over the same areas was scraped off without injury to the underlying bone buttress.

(3) The cartilage and underlying bone buttress were removed.

Following incision or removal of the articular cartilage without removal of the underlying bone buttress, there was no repair of cartilage. When

however, the underlying bone buttress was removed with the cartilage, thus opening up the marrow spaces the marrow in the vicinity of the defect became fibrous in character. Procallus granulation tissue developing from

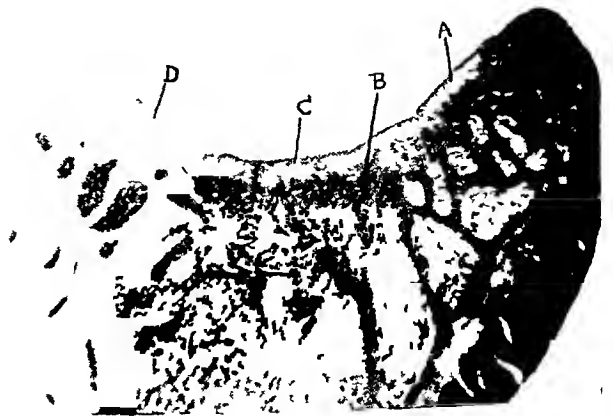


FIG 20.—Intercondylar groove of femur of rabbit, showing A—Original articular cartilage B—New bone buttress at site of removal of articular cartilage and underlying bone buttress C—New cartilage developed from medullary procallus granulations through pressure and motion of overlying patella D—Absence of cartilage in area in which articular cartilage was removed without injury to underlying bone buttress

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the vessels of the marrow invaded the clot filling the defect. Osteal fibroblasts proliferated along the capillaries and deposited osteoid material and bone. Where the procallus granulations were subjected to pressure and motion fibrocartilage was formed which is easily differentiated from the original articular cartilage.

If ununited fracture is the result of local anatomical conditions such as

(1) absence of subperiosteal callus, (2) the prevention of fusion of the internal or medullary procallus granulations of the fragments by the ingrowth of dense, relatively avascular fibrous tissue from the lacerated periosteum, and (3) the closure of the marrow spaces of the ends of the fragments by an osseous plug or bony buttress, we ought to be able to secure bony union by converting a case of non-union into a simple fracture, without the introduction of osteogenetic elements from without, as, for example, by the use of an autogenous bone graft.

In order to convert this type of non-union into a simple fracture, it is necessary (1) to elevate the periosteum for a short distance on either side of the fibrous bond, (2) to remove the fibrous band, (3) to open up the medullary spaces of the ends of the fragments, and (4) to prevent the recurrence of fibrous tissue ingrowth between the fragments.

With a tourniquet applied to the part an incision is made through the periosteum extending from one fragment to the other across the fibrous bond. Histologic examination of our experimentally produced specimens of non-union showed that in the healing process the fibrous layer of the periosteum becomes continuous over the fibrous bond. The periosteum and a thin shell of cortical bone is lifted up for a short distance on either side of the bond and separated from the latter. By lifting up a thin portion of

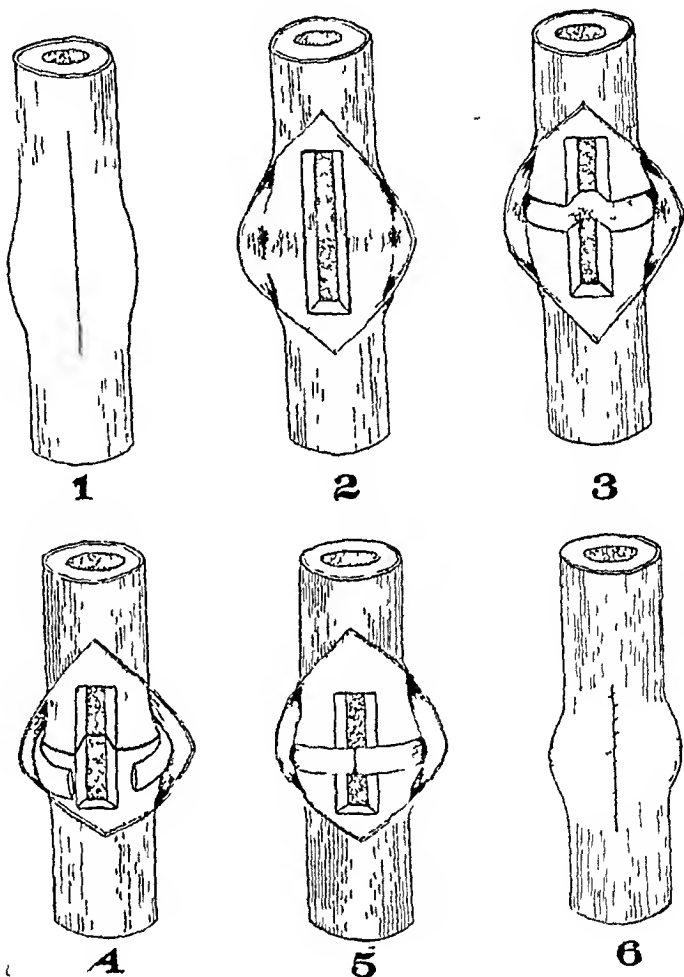


FIG. 21.—Schema to illustrate steps in operation for ununited fracture. 1—Incision of periosteum. 2—Lifting up of periosteum and thin flake of cortical bone and trough in fragments. 3—Removal of fibrous bond. 4—Approximation of fragments, with (5) fragments held in place with thin band of cortex of rib. 6—Suture of the periosteum.

the periosteum extending from one fragment to the other across the fibrous bond. Histologic examination of our experimentally produced specimens of non-union showed that in the healing process the fibrous layer of the periosteum becomes continuous over the fibrous bond. The periosteum and a thin shell of cortical bone is lifted up for a short distance on either side of the bond and separated from the latter. By lifting up a thin portion of

In our later cases of non-union in the human no means of internal fixation or means of preventing ingrowth of fibrous tissue has been used and bony union has occurred

In these cases, therefore, no osteogenetic tissue has been added from without nor has there been any alteration in the blood supply, nerve supply, calcium metabolism or other conditions, to which non-union has been attributed

CONCLUSIONS

Our roentgenologic, microscopic and experimental studies of non-union point to local anatomical conditions as the cause of non-union. These

anatomical conditions are the result of laceration of the periosteum usually flush with the fracture line and separation of the fragments. As the periosteum remains adherent or in close contact with the cortical bone little or no subperiosteal callus develops.

Union is therefore dependent upon the less active and less abundant medullary procallus granulation masses, which are prevented from fusing and from reestablishing vascular communication

between the fragments by the ingrowth of the dense avascular fibrous tissue from the periosteum. This latter acts as a limiting membrane.

With slight separation and immobilization of the fragments, firm fibrous union occurs, the fibres of the bond running for the most part parallel to the ends of the fragments. With moderate separation of the fragments and tension on the granulation tissue due to gravity, or muscular contraction, loose fibrous union results. The bond is similar in structure to a tendon, and the fibres of the bond extend in the direction of tension, for the most part parallel to the long axes of the fragments. The contour of the bone ends will depend upon the relative rates of growth of the subperiosteal and medullary procallus granulations and of the ossification of the latter. If the medullary procallus granulations have completely ossified the ends of the fragments will be serrated and irregular.

If after the development of fibrous union, restoration of function, particularly weight bearing occurs, the fibrous tissue is compressed. If, in addition to compression, there are sliding movements between the fragments, the



FIG. 26.—S—Tissue resembling synovial membrane from pseudarthrosis experimentally produced in dog. This tissue is found in portions of joint where there is motion without pressure.

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bundles of collagen fibres are ground and torn and irregular slits or clefts with ragged walls appear. Continued compression with motion causes necrosis of these fibres and they are gradually absorbed or remain in the clefts or joint space as débris. If ossification of the medullary procallus is incomplete at the time when motion and pressure begin, the ends of the fragments become rounded off, smooth and capped with fibrocartilage.

The end of the upper fragment is usually convex, while that of the lower fragment is concave. In those portions of the pseudarthrosis where motion is present but pressure absent a tissue resembling synovial membrane is seen.

The present investigation has been conducted with the hope of adding to our knowledge of the cause of non-union following fracture of the long bones. No attempt has been made to devise a new method of surgical treatment of non-union. The methods of the massive graft and bone chips have their indications and have been successful in the experience of many surgeons. The operative procedure described above has been used successfully in cases of non-union experimentally produced in the dog, and in cases of non-union in the human, in which there were good alignment and slight separation of the fragments. The procedure demonstrates that bony union can be secured unaided by the introduction of osteogenetic elements from without, by converting these cases of fibrous union into simple fractures and preventing the ingrowth of fibrous tissue from the lacerated periosteum.

THE EDUCATIONAL VALUE OF THE FOLLOW-UP

A REPORT OF 14 YEARS—FROM THE FIRST SURGICAL DIVISION (CORNELL MEDICAL) OF THE NEW YORK HOSPITAL

BY CHARLES L GIBSON, M D
OF NEW YORK, N Y

IN THE ANNALS OF SURGERY, December, 1919, a report of our Follow-Up work for a period of six years, ending January 1, 1919, was given. There was then described briefly an outline of the methods employed. We have made no radical change subsequently. Appended to this present report is a review of our follow-up work, continuing the first series and bringing it up to January 1, 1927—a total period of fourteen years.

It would seem wisest not to attempt to publish the combined figures of these two periods, as the character of the work at present naturally has undergone considerable deviations from the original period and the combined statistics would not necessarily show the usefulness of the present-day methods. Attention, however, will be called to a selected group of cases, contrasting results obtained in the two periods.

The lessons taught have been very striking and we have found that in some instances we have greatly improved our results by taking to heart the bad results and analyzing their causes and seeking to remedy the deficiencies.

There have been several partial reports on follow-up, notably two series of cases of chronic appendicitis, the first published in the *American Journal of the Medical Sciences*, May, 1920, the second in the *American Journal of the Medical Sciences*, December, 1924. In these we show some very poor results in the first group, but by applying the lessons learned we are able to show vastly better results in the second group.

A paper on the study of a twelve-year follow-up on "Final Results in the Surgery of Malignant Disease" was published in the ANNALS OF SURGERY, August, 1926, giving an accurate reflection of the very disheartening results of the treatment of malignant diseases in such material as we have.

The following statement summarizes the situation: "Of the 437 operative cases who came under our observation, only sixty-four are living to-day with—

TABLE I
Comparison of Two Periods

	1913-1919	1919-1927
Number of cases	8,456	12,144
Number of operations	7,175	9,025
Operative mortality	4 %	4 6%
Per cent of cases having follow-up report	75 5%	95 9%
Unsatisfactory results	13 3%	6 9%

THE EDUCATIONAL VALUE OF THE FOLLOW-UP

out recurrence and only thirteen have survived the artificial and questionable time limit of five years ”

All these follow-up systems are based on ward patients alone, as we have felt that we could not exercise the same rigid scrutiny of these private patients as is desirable, and it did not seem wise to have any double standard

It will be noted the increasing effectiveness of the follow-up system, 96 per cent of patients have been observed in the second period as opposed to 75 per cent in the first

The unsatisfactory results in the second period have been almost halved

A disquieting increase in the mortality in the second period, 4.6 per cent as opposed to 4 per cent, has attracted our attention. One explanation may be the increasing number of important cases and more radical surgery, especially in malignant diseases, also, the increasing mortality in appendicitis which we have noted as have other clinics throughout the world

The term “unsatisfactory” means that we have not accomplished the results generally sought for in operative treatment. In the case of malignant disease this might represent either an extension of the process or failure to relieve it entirely, as for instance palliative operation or recurrence of the condition. In the case of herniæ it will mean naturally a recurrence of the hernia

TABLE II
Digestive System

	1913-1919	1919-1927
Acute appendicitis	782 operations 34 deaths (4.3%)	990 operations 58 deaths (5.7%)
Chronic appendicitis	552 operations 30% unsatisfactory	773 operations 7% unsatisfactory
Cholecystitis and cholelithiasis	179 operations 12 deaths (6.7%)	347 operations 41 deaths (11.8%)
Tonsils	559 operations 1 death (epidemic men- ingitis)	1086 operations No deaths
Ulcer of stomach and duodenum	70 operations 6 deaths (8.5%) 9% unsatisfactory	169 operations 16 deaths (9%) 2% unsatisfactory
Ulcer of stomach and duodenum, perforating, acute	39 operations 10 deaths (25.6%)	63 operations 11 deaths (17.4%)
Abscess of liver	100% mortality	100% mortality
Adhesions of peritoneum	29% unsatisfactory	22% unsatisfactory
Hemorrhoids	184 operations 0 deaths 3 unsatisfactory	168 operations 0 deaths 2 unsatisfactory
Intestinal obstruction	36 operations 15 deaths (41.6%)	39 operations 18 deaths (46%)

This report will take up the question both of unsatisfactory results and the general mortality of groups

Acute Appendicitis—An increase from 4.3 per cent to 5.7 per cent mortality is in accordance with the findings quoted above. It is most interesting to note that patients coming under treatment early—our standard is whether or not the wound can be closed without drainage—the mortality is that of an interval appendicitis, as only one in two hundred dies, and these deaths occur largely in the more advanced period of life and are due to incidental complications such as pulmonary embolism.

In drained cases the mortality with no involvement of peritoneum is 2.10 per cent, with localized abscess 3.26 per cent, and with a definite peritonitis with no limiting adhesions 20.92 per cent.

Attention is also called to the rarity of fecal fistulæ by our methods of drainage, and their very benign character, usually closing up spontaneously without operative procedure. "Prophylaxis of Fecal Fistula in Operations for Acute Appendicitis," *American Journal of Surgery*, January, 1926.

Patients who have been operated on for acute appendicitis are generally greatly improved in health and their return complaints are practically negligible. With wide open drainage—use of the Mikulicz tampon, naturally a certain proportion of herniæ is to be expected (14 per cent). We always recommend young and vigorous individuals to have these herniæ repaired, as these operations are very easy as there is no loss of tissue, particularly fascia, the wide open drainage doing away with secondary sloughing of the tissues of the abdominal wall.

Cholecystitis and Cholelithiasis—The increase in the mortality percentage is rather discouraging. On the other hand, the second series represents a greater proportion of more extensive operations and the gradual tendency to discard the simple drainage operations. In the last two years the method of operating has become better standardized and made easier, by the safer employment of subperitoneal excision. "Aids to Cholecystectomy," *ANNALS OF SURGERY*, May, 1926. The more recent results have shown distinct improvement.

Ulcer of Stomach and Duodenum—The mortality remains the same, but the second series shows a very much larger proportion of radical operations. For all practical purposes no other treatment, but resection, for gastric ulcer is performed to-day. The greatly reduced percentage of unsatisfactory results, 2 per cent as opposed to 9 per cent, is an eloquent argument for the value of more radical surgery.

Perforating Ulcers of Stomach and Duodenum—In the treatment of perforating ulcer of the stomach and duodenum, it is our policy to deal only with the actual condition such operations as gastro-enterostomy, excision of the ulcer, resection of the pylorus being performed only when the indications are those of absolute necessity.

Few classes of cases make a better comeback than the patient with an acute

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perforation Eighteen per cent have some trouble, either post-operative adhesions or stenosis of the pylorus requiring a secondary operation

Abscess of Liver—Attention is called to the 100 per cent mortality in abscess of the liver We have no proper explanation for this fact

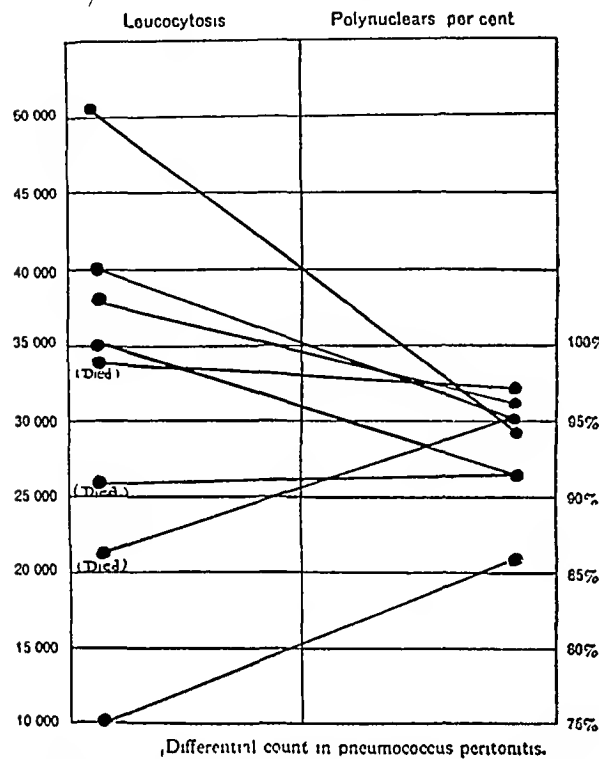


FIG 1—From "Pneumococcus Peritonitis" Transactions of the American Surgical Association, 1925

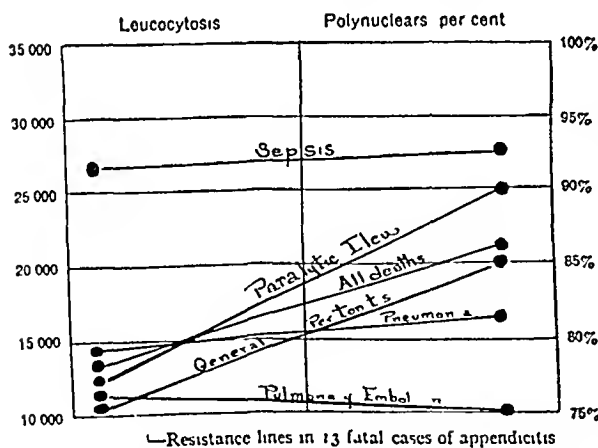


FIG 2—From "Pneumococcus Peritonitis" Transactions of the American Surgical Association, 1925

Intestinal Obstruction—The mortality of the two periods is respectively 41.6 per cent and 46 per cent Intestinal obstruction is still the most unsatisfactory form of acute abdomen Although refinements of diagnosis, increase in the number of skilled and experienced operators, and better facilities now exist, the mortality of intestinal obstruction remains about the same as when I first started to do surgery and I think that this state of affairs exists universally

It is entirely a question of early diagnosis and prompt relief The general practitioner seems to get no idea of what intestinal obstruction is until the patient shows the "classical" symptoms, which means he is very nearly moribund and in addition will require perhaps, a severer operation for relief as opposed to a very simple one—division of band, reduction of a volvulus and intussusception in the early stages

There is no phase of surgery which calls for missionary work more than the education of the practitioner He should be instructed that a mistaken diagnosis of possible early obstruction will generally result in a patient's surviving and chances can be taken accordingly

Pneumococcus Peritonitis—This seems to be diminishing in frequency as our diagnostic ability and resources seem to be on the increase

The behavior of the blood count in pneumococcus peritonitis is so typical that our attention is at once called to the possibility There is a very high percentage (Fig 1) of total leucocytosis with a high percentage of polymor-

phonuclears, a contrast to the spreading peritonitis of appendicitis (Fig 2) where the total leucocytosis as plotted out on my standard chart, is on a much lower level on the whole than the percentage of polymorphonuclears

TABLE III

Thyroid

	1913-1919	1919-1927
Goitre—simple and hyperthyroidism	9 operations 0 deaths Follow-up result 100% satisfactory	48 operations 5 deaths Follow-up result 100% satisfactory

Note —In the first series of cases 8 were asked to return for examination, but only 4 returned 100% is based on these four cases who came back and had satisfactory results

In the second series 43 cases were asked to return and 43 cases returned 100% is based on 43 cases instead of 4

Goitre—exophthalmic	9 operations 2 deaths (22%) Follow-up, based on 5 cases who returned, 20% unsatisfactory	25 operations 5 deaths (20%) Follow-up, based on 20 cases who returned, 100% satisfactory
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Operations on the thyroid have given very gratifying after results and the proportion of permanent cures is very high On the other hand, the mortality is much too high The class of material coming to us is largely of the severer type and it is possible some of these patients should not have been operated on at all

TABLE IV

Hernia

	1913-1919	1919-1927
Femoral	53 operations 1 death No recurrences	40 operations No deaths No recurrences
Femoral, strangulated	11 operations 1 death (9%) No recurrences	23 operations 1 death (4%) No recurrences
Inguinal	849 operations 2 deaths (2%) 37% recurred	895 operations 4 deaths (4%) 31% recurred
Inguinal, strangulated	41 operations 6 deaths (14%) 2 recurrences	58 operations 4 deaths (7%) 2 recurrences
Umbilical	21 operations 2 deaths (9%) 1 recurrence	31 operations 1 death (3%) 2 recurrences

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Umbilical, strangulated	9 operations 5 deaths (55%) 1 recurrence	11 operations 2 deaths (18%) 2 recurrences
Ventral	39 operations 2 deaths (5%) 1 recurrence	89 operations 2 deaths (2%) 9 recurrences
Ventral, strangulated	5 operations 3 deaths (60%)	7 operations 2 deaths (28%)

On the whole, our herniæ results are satisfactory. We have not resorted to any unusual and, I think, generally unnecessary procedures such as the Gal-
lie operation, relying on doing the conventional and perfectly satisfactory
operations in a thorough and radical manner, *e g* using great care to isolate
and remove direct sacs and transplanting the rectus muscle and fascia for the
plastic repair of the canal.

The more extensive use of local anæsthesia in the various types of
strangulated herniæ, especially umbilical and ventral, has greatly reduced
the mortality.

We continue to use for the extreme incisional hernia the operation
described in the ANNALS OF SURGERY for August, 1920, with increasing sat-
isfaction, and believe it is the solution of this problem as we have not refused
any case that came to us, no matter how extensive, and have had only one par-
tial recurrence in this whole series.

We are applying this same principle more and more to the ordinary
umbilical hernia, believing it is more efficacious than the overlapping Mayo-
Blake operation.

TABLE V
Reproductive Organs
Female

	1913-1919	1919-1927
Extrauterine	51 operations 2 deaths (4%) Unsatisfactory 12%	52 operations 4 deaths (7.6%) Unsatisfactory—0
Chronic salpingitis	211 operations 5 deaths (2%) Unsatisfactory 10%	164 operations 5 deaths (3%) Unsatisfactory 12%
Prolapse of uterus	21 operations 1 death (4.7%) Unsatisfactory 20%	23 operations 0 deaths Unsatisfactory 9%

Male

Hydrocele	62 operations 0 deaths Unsatisfactory 3%	68 operations 0 deaths 0 unsatisfactory
Varicocele	78 operations 0 deaths Unsatisfactory 2.7%	31 operations 0 deaths Unsatisfactory 3.7%

Prolapse of Uterus —The second period shows considerable diminution in the per cent of unsatisfactory operations, the result from taking to heart the large percentage of unsatisfactory in the first period. The tendency has been to do more radical operations and these have been applied in increasing frequency to the severest cases.

A very satisfactory operation for the bad cases is a thorough repair of the ectocele and cystocele and then a suspension of the uterus, either by a very taut plication of the ligaments or performing a supravaginal hysterectomy and reimplanting the ligaments in the stump of the cervix and bringing the bladder on top and back of the uterine stump.

TABLE VI
Respiratory System

	1913-1919	1919-1927
Suppurative pleurisy	81 operations 13 deaths (14.6%) Reoperations 7.8% Unsatisfactory 4.4%	134 operations 13 deaths (9.6%) Reoperations 8% Unsatisfactory 3.3%

There is a marked drop in the mortality of empyema.

The experience gained from the treatment of empyema during the War has been applied to good advantage, in the realization of the great difference between the influenza empyema and the ordinary pneumococcus empyema, and the difference in character of treatment.

Massive Collapse —Of late we have detected massive collapse of the lung, with increasing frequency and have been relieved to recognize the underlying condition which always gets well, quieting our fears of a possible impending pneumonia. Since this report was closed we have had two extraordinary examples of the cause of massive collapse and its cure.

Our present House Surgeon, Dr. Wade Duley, conceived the idea of placing the patient on the sound side and hitting the chest a smart slap on the affected side causing the patient to make violent expulsive efforts and bring up a large plug of muco-pus. The clinical symptoms were relieved at once and X-ray pictures taken respectively a half hour and fifteen minutes after showed almost complete re-aeration of the chest, with a return of the heart and trachea to their normal position.

TABLE VII
Pulmonary Embolism—1919-1927

No. of cases following operation—35
Of these 11 lived
24 died
No. of cases without operation—2
Both died
No. of operations performed in this period—9025
24 or 3% died of pulmonary embolism
Out of 990 operations for acute appendicitis 2 (2%) died of pulmonary embolism
Out of 773 operations for chronic appendicitis 2 (2 plus %) died of pulmonary embolism

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Out of 1,171 operations for hernia, 7 cases (5%) died of pulmonary embolism
 Out of 347 operations for gall-bladder disease 2 (5%) died of pulmonary embolism
 Out of 600 operations on the pelvic viscera 2 (3%) died of pulmonary embolism
 Out of 763 operations on remaining gastro-intestinal conditions 4 (5%) died of pulmonary embolism

TABLE VIII

Fractures

	1913-1919	1919-1927
Fractures	236 cases returned	724 cases returned
	53 excellent	314 excellent
	162 satisfactory	395 satisfactory
	21 unsatisfactory 8.8%	15 unsatisfactory 2%

Following the impetus of the War, in accordance with the general tendency to give more special attention to fractures, the gratifying reduction to 2 per cent unsatisfactory cases is noted

The mortality of gunshot wounds of the abdomen continues to be very high (60 per cent for entire period) A number of these of course are multiple injuries, including the thorax Here again, contrary to many optimistic statements, modern surgery has not brought any signal relief

TABLE IX

Fracture of Skull

	1913-1919	1919-1927
No of cases	43	66
Operations	10*	5†
Died following operation	6	0
Died without operation	8	25
Total mortality	32.5%	37.8%
Operative mortality	60 %	0
% operative cases	23.2%	7.5%

* Nine for decompression, one suture of laceration

† Four for decompression, one for removal of bullet and mastoidectomy

The mortality of fracture of the skull does not change very much and keeping it under 40 per cent is on the whole quite good

It has not been our policy to resort so freely to operation as has been recommended by so many surgeons as we believe there is very little indication except for the relief of pressure, whether by epidural clot or bone

A very good paper by McCreery and Berry, read before the New York Surgical Society, April 20, "A Study of 520 Cases of Fractures of the Skull" from material from the First Surgical Division of Bellevue Hospital, gives a total mortality of 39 per cent and an operative mortality of 53 per cent

In both Bellevue Hospital and the New York Hospital the material is brought in by the ambulance and covers very much the same sort of district

The Use of Insulin—The second period has also witnessed the introduction of insulin† which has been a valuable adjunct for the preparation of

† "The Mortality of Surgical Complications in Diabetes", W Morris Weedon, Journal of A M A, April 12, 1924

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REPORT OF FOLLOW-UP WORK FROM JANUARY 1, 1919, TO JANUARY 1, 1927

Diagnosis	No of cases	No of deaths	No of op	Excel lent	Sat	Unsat
<i>Congenital Abnormalities and Malformations</i>						
Branchial cyst	2		2	2		
Tongue	2		2		2	
Intestines	3	3	3			
Stomach	1		0			
Mesenteric artery	1		1	1		
Bones	2		0			
Thyroglossal cyst	7		6	6		
Ears	1		1		1	
Lip and palate	13	3 (1)	12	3	3	1
Feet	4		3	2	2	
Hands	3		3	2	1	
Muscles	1		1		1	
Ribs	4		3		2	1
Uterus	2		2	1	1	
Vagina	2		1	1		
Penis	3		1		1	
Testicle	12		11	7	3	
Bladder	2	1	2	1		
Kidney	4		2		2	
<i>Blood</i>						
Leuchæmia	2		0		1	
Splenic anemia	7	2	6		3	
Hemorrhagic pupera	2	1	2	1		
Secondary anemia	1		0			
Hemophilia	2		0		1	
Pernicious anemia	4	1	4		2	
<i>Diseases of Bones</i>						
Chondrodystrophia foetalis	1		0			
Curvature of spine	3		0			
Deformity of mandible, acquired	1		0			
Epiphysitis	1		0	1		
Faulty union	26		25	2	19	3
Necrosis	1		1	1		
Osteomyelitis	159	11	155	48	79	9
Osteomalacia	1	1	1			
Periostitis	8		6	3	2	
<i>Bursæ</i>						
Bursitis	37		34	20	14	
<i>Circulatory Systems</i>						
Aneurism	8	1	6	2	2	
Arteriosclerosis	2		1		1	
Endarteritis obliterans	16		11	1	9	
Phlebitis	2		0			
Varicose veins	55	1	51	26	18	2
Cardiac valvular disease	2		0			
Myocarditis	1	(1)	0			
Ac purulent pericarditis	1	1	1			

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REPORT OF FOLLOW-UP WORK FROM JANUARY 1, 1919, TO JANUARY 1, 1927 —

Continued

Diagnosis	No of cases	No of deaths	No of op	Excel- lent	Sat	Unsat
<i>Digestive System</i>						
Appendicitis, acute	998	58	990	697	182	10
Appendicitis, chronic	820	7	773	460	218	52
Cholecystitis and cholelithiasis	423	41	347	186	97	12
Adhesions about gall-bladder	2		1	1		
Cholangitis	2	1	2		1	
Stenosis of gall-bladder	1		1		1	
Biliary fistula	1		1		1	
Abscess of intestine	1	1	1			
Colitis	10		4	1	2	
Constipation	29		0			
Cyst of mesentery	1	1	1			
Diverticulitis	6		6	3	3	
Duodenitis	1	1	1			
Enteritis (acute)	1	(1)	0			
Fecal fistula	2		2	1	1	
Gastro-enteritis	5		0			
Intestinal hemorrhage	1		1	1		
Mesenteric thrombosis	3	3	3			
Intestinal neurosis	3	1	1			
Intestinal obstruction	43	18	39	8	7	5
Splanchnoptosis	16		0			
Ulcer intestine	4	2	4	2		
Abscess of liver	7	6	7			
Cirrhosis	4	2 (1)	2			
Hepatitis	1	1	1			
Deformity of palate acquired	1		1	1		
Angina ludovici	1	1	1			
Stomatitis	1		0			
Abscess pharynx	9		9			
Pharyngeal hemorrhage	1		0			
Chr inflammation of salivary gland	1		1	1		
Acute parotitis	2	1	2		1	
Fistula of salivary gland	1		1	1		
Tonsils & Adenoids	2025		1086			
Tonsillar abscess	17		13			
Acute glossitis	1		0			
Foreign body in œsophagus	1		0			
Torsion of omentum	2		2	2		
Pancreatitis	10	2 (1)	7	2	4	1
Adhesions of peritoneum	120	5	78	24	32	16
Pelvic abscess	14	2	12	4	4	
Subphrenic abscess	1		1	1		
Peritonitis	16	11	16	3	1	
Peritonitis pneumococcus	5	3	5	2		
Abscess rectum	50	1	48	28	14	1
Fissure of anus	16		15	12	2	1
Fistula in ano	52		52	30	13	2
Foreign body in rectum	1		1	1		
Hemorrhoids	179		168	124	23	2
Proctitis	3		0			
Prolapse rectum	8		6	4	1	1
Pruritis	2		1			1
Spasm of rectum	1		1	1		
Stricture of rectum	2		2	1	1	
Ulcer of anus	1		1			
Achylia gastrica	1		0			
Adhesions about stomach	1		0			
Cardiospasm	1	1	1			

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Continued

Diagnosis	No of cases	No of deaths	No of op	Excel lent	Sat	Unsat
<i>Digestive System—(Continued)</i>						
Nervous dyspepsia	3		0			
Gastroduodenitis	2		0			
Gastritis	9		1	1		
Gastroptosis	6		0			
Hypochlorhydria	1		0			
Hematemesis	2	1	1		1	
Pylorospasm	3		0			
Ulcer stomach	64	13	51	20	15	
Ulcer duodenum	132	3	118	73	36	4
Ulcer stomach, ac perf	30	4	29	9	15	
Ulcer duodenum, ac perf	35	5	34	12	16	
Ulcer stomach, chr perf	3	1 (1)	2		1	
Ulcer duodenum, chr perf	4		4	2	2	
Pyloric stenosis	2		2	1	1	
<i>Ductless Glands and Spleen</i>						
Goitre, simple	49	5	48	37	6	
Goitre, exophthalmic	25	5	25	14	6	
Hemorrhage into subrenal gland	1	1	1			
<i>Ear</i>						
Mastoiditis	8		8	6	1	1
Otitis media	2		0			
<i>Hernæ</i>						
Epigastric	18		16	9	5	1
Femoral	41		40	28	10	
Femoral, strang	23	1	23	12	7	2
Inguinal						
Indir, 1 side	652	2	617	509	66	9
Direct, 1 side	78		75	61	6	6
Dir and indir, 1 side	81		80	68	5	5
Bilat indir	74	2	65	52	6	3
Bilat dir	15		15	12	2	1
Bilat dir and indir	43		43	35	4	3
Inguinal, strang	63	4	58	48	4	2
Diaphragmatic hernia	1		0			
Internal hernia, strang	1		1	1		
Umbilical	35	1	31	23	3	2
Umbilical, strang	11	2	11	4	2	2
Ventral	98	2	89	52	18	9
Ventral, strang	7	2	7	3	2	
<i>Infective Diseases</i>						
Abscess	142	1 (1)	136	72	21	4
Carbuncle	37	3	37	15	6	2
Cellulitis	309	7	285	118	114	22
Chicken pox	1		0			
Diphtheria	4		0			

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REPORT OF FOLLOW-UP WORK FROM JANUARY 1, 1919, TO JANUARY 1, 1927 —

Continued

Diagnosis	No of cases	No of deaths	No of op	Excel- lent	Sat	Unsat
<i>Infective Diseases—(Continued)</i>						
Erysipelas	1		0			
Fever—unknown origin	1		1		1	
Furunculosis	2		2	1		
Gonococcus infection	12		4	2	1	
Rheumatic fever	2		0			
Syphilis	31		5		2	
Tuberculosis of						
Bones	22	2	15	3	9	
Digestive system	24	3	19	1	6	4
Joints	20		12	4	5	1
Lymph-nodes	82		76	9	54	8
Muscular system	2		2		1	1
Reproductive organs—female	11	2	11	2	5	
Reproductive organs—male	12		9	2	2	1
Respiratory	6		1			
Skin	2		1			1
Urinary	21	1	9	3	5	
Ac milary	3	3	3			
Typhoid fever	1		1	1		
<i>Joints</i>						
Ankylosis	17		13		11	1
Arthritis	65		46	8	34	2
Arthritis deformans	1		0			
Contracture of joint	5		5		5	
Coxa vara	1		1		1	
Genu varum	3		1		1	
Genu valgum	3		3	1	2	
Hallux valgus	12		9	3	6	
Pes planus	3		3	1	2	
Pes valgus	2		2		2	
Talipes	3		3		2	
Trigger thumb	1		1			1
Loose body in joint	1		1		1	
<i>Lymphatic System</i>						
Abscess	27		27	20	4	
Lymphangitis	5		0			
Lymphadenitis	40		34	21	7	
Elephantiasis	3		2		1	1
Hodgkin's disease	9		2			3
<i>Diseases of the Mind</i>						
Psychosis	3		0			
<i>Miscellaneous</i>						
Acidosis	2		0			
Amputation stump	10		8	4	4	
Cicatricial contracture	21		21	3	15	2

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REPORT OF FOLLOW-UP WORK FROM JANUARY 1, 1919, TO JANUARY 1, 1927—

Continued

Diagnosis	No of cases	No of deaths	No of op	Excel lent	Sat	Unsat
<i>Miscellaneous—(Continued)</i>						
Diabetes	2		0			
Gangrene—diabetic	10	5	9	1	2	
Gangrene—arteriosclerotic	3	2	3		1	
Gangrene—traumatic	1		1		1	
Gout, acute	1		1			1
Hypertrophic osteo-arthritis	2		0			
Malingering	1		0			
Migraine	1		0			
Obesity	1		0			
Rickets	5		0			
Scurvy	1		0			
Shock	1		0			
Shell shock	1		0			
Sinus, P O	13		11	4	6	
Unknown	26		3	1	2	
<i>Muscular System</i>						
Abscess	2		2	2		
Contracture of muscle	8		8	1	3	4
Contracture of tendon	3		3		2	1
Ganglion	7		6	6		
Hammer toe	6		6	5		
Myositis	5		3		2	
Tenosynovitis	15		14	4	6	4
<i>Nervous System</i>						
Abscess of brain	2	(1)	1	1		
Epilepsy	4	1	2		1	
Hemorrhage into cerebrum	1	(1)	0			
Hysteria	4		0			
Meningitis—cerebrospinal	1	1	1			
Neuralgia	5		0			
Neurasthenia	4		0			
Neurolysis	2		2		2	
Neuritis	2		0			
Post polio myelitis	12		11	1	9	1
Paralysis -	4		1			
Neurosis	1		0			
Tabes dorsalis	2		0			
Tic	1		0			
Thrombosis of sigmoid sinus	1		1	1		
<i>Parasites</i>						
Actinomycosis	2	1	2		1	
Echinococcus	6	2	6	2	1	
Dysentery entamoebic	1		1	1		
Oxyuris vermicularis of appendix	1		1	1		
<i>Poisonings</i>						
Chlorine	5		0			
Lead	1		0			
Sulphuric acid	1	1	1			

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REPORT OF FOLLOW-UP WORK FROM JANUARY 1, 1919, TO JANUARY 1, 1927 —
Continued

Diagnosis	No of cases	No of deaths	No of op	Excel- lent	Sat	Unsat
<i>Reproductive Organs (Female)</i>						
Functional disturbances	25		9	3	3	1
Abscess breast	28		27	23	3	1
Mastitis	24		19	17	1	
Abscess ovary	3		2		2	
Extrauterine	56	4 (1)	52	37	14	
Hematosalpinx	3		3	2	1	
Hydrocele of round ligament	1		1	1		
Oophoritis	1		0			
Salpingitis, acute	70	2	46	25	13	
Salpingitis, chr	180	5	164	79	51	16
Anteflexion uterus	8		8	2	4	2
Prolapse uterus	24		23	12	8	2
Retroversion uterus	46		39	17	15	5
Retroflexion uterus	2		2		1	1
Endocervicitis	1		1	1		
Endometritis	102	3	100	40	32	12
Endotrachelitis	1		1		1	
Hypertrophy of cervix	1		0			
Hypertrophy of round ligament	1		1		1	
Laceration cervix	7		6	3	3	
Metritis	4	2	4	2		
Stricture of uterine canal	1		1			1
Subinvolution of uterus	3		2		2	
Vulvo-vaginal abscess	4		4	2		
Abscess of Bartholin's gland	9		9	6	3	
Adhesions about clitoris	1		1	1		
Atresia of vagina	2		2			
Hyp of vulva	1		1		1	
Lac pelvic floor	62		60	29	27	3
Relaxed pelvic floor	65		60	22	28	7
Vulvitis	1		0			

Reproductive Organs (Male)

Phimosis and redundant prepuce	125	(1)	116			
Abscess of prostate	2	1	2		1	
Chr prostatitis	1		1	1		
Enlargement of prostate	17	2 (1)	12	6	2	
Hematocele	3		2		2	
Hydrocele	75		68	57	7	
Varicocele	36		31	21	5	1
Epididymitis	5		2	1	1	

Respiratory System

Bronchitis	4		0			
Maxillary sinusitis	2		0			
Abscess of lung	8	6	8	1		
Pulmonary embolism	1	1	1			
Infarct of lung	1		1	1		
Supp pleurisy	137	13 (1)	134	86	27	2
Pneumonia	6	(1)	2		1	
Ac laryngitis	1	(1)	0			

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REPORT OF FOLLOW-UP WORK FROM JANUARY 1, 1919, TO JANUARY 1, 1927 —

Continued

Diagnosis	No of cases	No of deaths	No of op	Excel- lent	Sat	Unsat
<i>Skin, Hair and Nails</i>						
Cicatrix of skin	2		2	1	1	
Dermatitis	1		0			
Eczema	1		0			
Ingrowing toe nail and paronychia	10		10	5	4	
Keloid	1		1		1	
Leukokeratosis of cheek	1		1	1		
Ulcer of skin	23		9	2	6	1
<i>Tumors (Benign)</i>						
Adenoma of						
Breast	2		2	2		
Cervix	1	1	1			
Liver	1	1	1			
Rectum	1		1	1		
Uterus	1		1	1		
Angioma of						
Face	7		6	1	3	
Lower extremity	1		1	1		
Upper extremity	3		3	2		
Back	2		1	1		
Parotid	1		1		1	
Tongue	1		1			
Cystoma of						
Axilla	1		1		1	
Breast	1		1	1		
Broad ligament	1		1		1	
Buttock	2		2		2	
Cervix	1		1	1		
Eyelid	1		0			
Liver	1		1		1	
Neck	3		3	2	1	
Olecranon bursa	1		1	1		
Ovaries	100	2	89	50	29	3
Pancreas	1		1		1	
Scalp	3		3	1		
Ulna	1		1	1		
Fibroma of						
Breast	5		5	4	1	
Labium majus	1		1			
Mouth (epulis)	5		4	4		
Nose	1		1	1		
Ovary	1		1	1		
Rectum	1		1	1		
Jaw	1		1	1		
Lipoma of						
Chest wall	1		1	1		
Neck	8		7	7		
Back	9		9	8	1	
Scalp	1		1	1		
Upper extremity	15		15	8	4	
Lower extremity	8		8	4	1	1
Myeloma, multiple	1		0			
Neuroma of						
Arm	2		1	1		
Sublingual	1		1		1	

THE EDUCATIONAL VALUE OF THE FOLLOW-UP

REPORT OF FOLLOW-UP WORK FROM JANUARY 1, 1919, TO JANUARY 1, 1927 —

Continued

Diagnosis	No of cases	No of deaths	No of op	Excel- lent	Sat	Unsat
<i>Tumors (Benign)—(Continued)</i>						
Osteoma of						
Femur	2		2	2		
Os Calcis	2		2	1	1	
Tibia	2		2		1	
Papilloma of						
Face and mouth	5		5	4		
Finger	2		2	2		
Cervix	4		4	1	3	
Urethra (caruncle)	5		4	3	1	
Vulva	1		1	1		
Perineum	1		1		1	
Descending colon	1		1	1		
Buttock	1		1			1
Rectum	7		6	4	1	
Uterus	1		1		1	
Retention cyst of						
Breast	1		1	1		
Broad ligament	1		1	1		
Face and neck	10		10	8	2	
Lingual duct	2		2	1	1	
Parotid	1		1	1		
Bartholin's gland	2		2	1		
Back	2		2	1		
Vaginal wall	1		1	1		
Scalp	1		1			
Upper extremity	4		4	3	1	
Lower extremity	1		1	1		
Rhinophyema	1		1	1		
Teratoma of						
Ovary	5	1	5	4		
Chest wall	2		2	2		
Sacrum (pilonidal cyst)	27		27	20	5	1
Unknown tumor of						
Ampulla vater	1		1		1	
Neck	1		0			
Spinal cord	1		0			
Mediastinum	1		0			
Thyroid	1		1			
Parotid	1		0			
Lcg	1		0			
Adeno-angioma cervix	1		1	1		
Cystadenoma breast	3		3	3		
Cystadenoma ovary	2		2	1		
Fibroadenoma breast	8		8	7	1	
Fibrolipoma of skin						
of arm	1		1	1		
neck	1		1	1		
Fibromyoma uterus	138	6	125	75	41	2
Lymphangioma of						
Femoral canal	1		1	1		
Neck	1		1	1		
Neurofibroma of						
Thigh	1		1	1		
Ostcochondroma of						
Tibia	1		1	1		
Ilium	1		1	1		

CHARLES L GIBSON

REPORT OF FOLLOW-UP WORK FROM JANUARY 1, 1919, TO JANUARY 1, 1927 —

Continued

Diagnosis	No of cases	No of deaths	No of op	Excel lent	Sat	Unsat
<i>Tumors (Malignant)</i>						
Adenoma, malignant of sigmoid	1		1			
Carcinoma of						
Appendix	5		5	3		
Bone, frontal	1		1			
Breast	48	1	44		16	2
Bladder	3	1	1			
Gall-bladder	12	4	12			1
Intestines	37	21 (1)	36		5	
Kidney	2		1			
Larynx	3	(1)	1			
Lip	1		1			1
Liver	6	1	6			
Submaxillary gland	1		1		1	
Retroperitoneal lymph-nodes	1		0			
Mediastinum	1	(1)	0			
Mouth	1		0			
Oesophagus	7	1	3			
Pancreas	3	2 (1)	2			
Omentum	4	1	3			
Rectum	17	3	10		3	1
Penis	2		2		1	
Prostate	4		1			
Testicle	1		1			
Scalp	1		1		1	
Stomach	67	20 (1)	53		5	2
Tonsil	2		0			
Thyroid	2		1		1	
Ovaries	13	3	13		1	
Uterus	32	4 (1)	17		3	1
Epithelioma of						
Branchial cleft	1		0			
Face and scalp	9		7		2	1
Thumb	1		1			
Leg	2		1			
Lip	4		2			
Lymph-nodes	1		1			
Cervix	2		0			
Scrotum	1		1			
Shoulder	1		1			
Endothelioma of						
Chest wall	1		1		1	
Axillary nodes	1		1		1	
Hypernephroma of						
Kidney	2		2		1	
Melanoma						
Inguinal region	2		1			
Sarcoma of						
Bones	9	1	8		4	
Upper extremity	4		2		2	
Lower extremity	5		5			
Reproductive organs, female	4		3		2	
Back	1		1		1	
Kidney	3		1			
Maxilla	1		0			
Neck	3		3		2	1

THE EDUCATIONAL VALUE OF THE FOLLOW-UP

REPORT OF FOLLOW-UP WORK FROM JANUARY 1, 1919, TO JANUARY 1, 1927 —

Continued

Diagnosis	No of cases	No of deaths	No of op	Excel- lent	Sat	Unsat
<i>Tumors (Malignant)—(Continued)</i>						
Intestines	8	1	7			
Gum	1		1		1	
Lymph-nodes	7		4		2	
Retroperitoneal fascia	1		0			
Stomach	2		2		1	
Spleen	1	1	1			
Axilla	1		1			
Breast	1		1			
Myxochondroendothelioma	3		3		3	
Neurocytoma of						
Kidney	1		1			
Pancreas	1	1	1			
Teratoma of						
Testicle (malignant)	2		1			
<i>Urinary Organs</i>						
Cystitis	11		0			
Calculus in bladder	2		1		1	
Retention of urine	2		0			
Perinephritic abscess	13		13	12	1	
Hydronephrosis	6	1	2	1		
Infarct of kidney	1		0			
Nephritis	4	(1)	2	1		1
Nephrolithiasis	41	1	19	8	5	3
Nephroptosis	8		2	2		
Pyelitis	35		2			
Pyelonephritis	1		1	1		
Pyonephrosis	9	1	4	1	2	
Ureteral colic	29		1		1	
Calculus in ureter	31		7	6	1	
Stricture ureter	7		1		1	
Stricture urethra	16	2	15	5	6	2
Urethritis	1		0			
Recto-urethral fistula	1		0			
<i>Obstetrical Conditions</i>						
Abortion	77	(1)	65	25	15	
Accidental hemorrhage of pregnancy	1		1	1		
Mammillitis	1		0			
Pregnancy	12		0			
Septicæmia, Puerperal	1	(1)	0			
Toxemia of pregnancy	1		0			
<i>Injuries</i>						
Fracture of						
Ankle-joint	43		3	18	24	
Clavicle	24		6	12	10	
Elbow	9		5	3	5	1
Bones of face	7		2	2	2	
Femur	61	(9)	7	17	24	2
Foot, Bones of	29		5	5	21	

CHARLES L GIBSON

REPORT OF FOLLOW-UP WORK FROM JANUARY 1, 1919, TO JANUARY 1, 1927 —

Continued

Diagnosis	No of cases	No of deaths	No of op	Excel- lent	Sat	Unsat
<i>Injuries—(Continued)</i>						
Forearm, Bones of	194		41	91	91	3
Hand, Bones of	30		10	12	15	3
Humerus	83		19	28	51	
Jaw	10		4	2	4	
Leg	117		25	58	50	3
Patella	23		21	7	14	1
Pelvis	11	(1)	0	4	6	
Ribs	28	(5)	0	1	7	
Scapula	2		0	1	1	
Skull and spine	81	(26)	5	12	26	
Wrist	89		5	41	40	2
Contusion of bone	3		0			
Gunshot wound of bones	1		1	1		
Lac wound of vein	1		0			
Digestive system						
Avulsion of tooth	1		0			
Contusion cæcum	1		1		1	
Foreign body in						
Intestines	7		1	2		
Stomach	2		0			
Esophagus	3		0			
Gunshot wound of						
Intestines	7	5 (1)	6		1	
Lacerated wound of						
Gum	1		0			
Intestines	2	1	2		1	
Rupture of						
Intestines	1	1	1			
Eye, Laceration of	2		0			
Joint						
Dislocation of						
Ankle	2		0	1	1	(1)
Cartilage	22		16	12	5	1
Coccyx	2		2		1	
Elbow	9		2	4	4	
Radius	1		1	1		
Foot, bones of	4		0	1	2	
Hand, bones of	8		5	5	3	
Hip	2		1		2	
Patella	2		0		2	
Shoulder	26		4	2	18	(2)
Vertebrae	1		0			
Wrist	7		3	2	5	
Foreign body in joint	1		1	1	1	
Hemorrhage into joint	2		1	1		
Lacerated wound of joint	1		1	1		
Sprain of joint	22		0			
Traumatic synovitis	5		3	2	2	
Muscular system						
Incised wound of tendon	23	1	23	3	13	4
Lac wound of tendon	71		71	14	46	8
Lac wound of muscle	1		1	1		
Rupture of muscle	5		2		3	
Rupture of tendon	8		7		7	
Strain of muscle	5		0			
Nervous system						
Compression nerve	2		2		1	
Rupture of nerve	1		1			1
Concussion brain	31		0	5	4	

THE EDUCATIONAL VALUE OF THE FOLLOW-UP

REPORT OF FOLLOW-UP WORK FROM JANUARY 1, 1919. TO JANUARY 1, 1927 —
Continued

Diagnosis	No of cases	No of deaths	No of op	Excel- lent	Sat	Unsat
Lac and incised wd of nerve	5		5		5	
Bullet wound spinal cord	1		1		1	
Gunshot wound brain	1	(1)	0			
Reproductive organs						
Burns of penis	1		0			
Contusion testicle	1		0			
Foreign body in vagina	1		1		1	
Hæmatoma of penis	1		0			
Hæmatoma of spermatic cord	1		1	1		
Lac wound penis	1		1	1		
Lac wound scrotum	1		1		1	
Lac wound labium majus	1		1	1		
Respiratory System						
Lac wound of lung	1		0			
Spleen						
Rupture of	4	(1)	3	2	1	
Laceration of	1		1		1	
Urinary organs						
Lac kidney	3		1	1		
Lac urethra	2		1		1	
Gunshot wound kidney	1		1	1		
Rupt urethra	3		3	1	1	
Stab wound kidney	1		1		1	
Contusion kidney	2		0		1	
Abdominal wall						
Abrasion	2		0			
Contusion	11		2	2		
Foreign body	1		1	1		
Gunshot wound	3		3	3		
Hæmatoma	1		0			
Stab wound	3		3	2	1	
Back						
Abrasion	2		0			
Contusion	17		0			
Foreign body	3		3	1	1	
Hæmatoma	2		0			
Lac wound	1		1		1	
Strain	6		0			
Chest wall						
Abrasion	1		0			
Burns	2	(1)	0			
Contusion	8		0			
Gunshot wound	4	(1)	2	1		
Incised wound	1		1	1		
Stab wound	1		1	1		
Lower extremities						
Abrasion	4		0			
Avulsion toes	3		3		3	
Avulsion skin of leg and thigh	2	2	2			
Burns	9		3	1	2	
Contusion	19		0			
Crush of toe	1		1			1
Crush of foot	3		2		1	1
Foreign body	16		15	7	2	
Frostbite toe	1		1		1	
Hæmatoma	3		2	1	1	
Gunshot wound	6		2	2		
Lac wound foot	4		1	1		
Lac wound leg	6	(1)	5	2	3	

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REPORT OF FOLLOW-UP WORK FROM JANUARY 1, 1919, TO JANUARY 1, 1927 —
Continued

Diagnosis	No of cases	No of deaths	No of op	Excellent	Sat	Unsat
Punct wound foot	5		4	2	2	
Sprain	4		0			
Stab wound of knee	1		1	1		
Upper extremities						
Abrasion	1		1			
Avulsion finger	87		80	26	47	2
Avulsion of arm	1	1	1			
Avulsion of hand	2		2		2	
Burn	5		3	1	2	
Contusion	19		0			
Crush of finger	14		14	3	9	1
Crush of hand	6		6		3	3
Foreign body	41		40	15	13	
Gunshot wound	4		4	3	1	
Incised wound finger	2		2		1	
Incised wound arm	1	1	1			
Lac wound finger	30		26	11	12	2
Hand	24		24	4	16	2
Arm	7		7	1	3	2
Axilla	1		1		1	
Shoulder	1		0			
Punctured wound	2		2	1	1	
Sprain	1		0			
Face and Scalp						
Abrasion	3		0			
Burn	8		0			
Contusion	9		0			
Hæmatoma	3		0			
Lac wound	51		32	14	6	
Miscellaneous						
Intra-abdominal hemorrhage	1		1	1		
Operation wound	2		0			
Neck						
Foreign body	2		1	1		
Contusion	1		0			
Burn	1		1		1	
Lac wound	1	(1)	0			
Contusion pubic region	1		0			
Multiple injuries	21	(7)	2	1	1	
	12,144	418 (79)	9025	4481	2528	361

NOTE Some of the headings have been omitted for the sake of simplicity including died after discharge
Total for these headings is as follows

Previous operation—485

Patients asked to return—7915

Patients returned—7595

Died after discharge—167

39 of these had no operation and

19 of these died of a condition in no way related to the operation

patients for operation, lowering the mortality of operation and also the use of glucose insulin in shock. A paper by P. A. Wade on this subject is now in press.

Finally it may be stated, of late we have been making observations on the frequency with which acute dilatation of the stomach follows operations on the upper abdomen.

It is customary in most clinics to place these patients, particularly the stomachs, in Fowler position. We wondered whether the crowding down of the intestines into the pelvis might cause a drag on the root of the mesentery and the superior mesenteric artery, and so for the past few months patients have been placed flat, in the ordinary recumbent position. We have not as yet accumulated enough statistics to warrant definite deductions, but the experience so far would seem to have diminished the incidence of acute dilatation.

As is the case in the 1913-1919 report, complete statistical tables are appended.

ROBERT ABBE

1851-1928

MARCH 7, 1928 marked the passing of a great surgeon and the termination of a beautiful life, full of achievement for the benefit of humanity

It is interesting to note that Abbe as an extraordinarily skillful and resourceful surgeon, a pioneer in many of the developments of modern sur-



Dr Robert Abbe, 1851-1928

gery, should have also become the earliest and greatest exponent of surgery's antithesis—Curietherapy

He was born and educated in New York City For two years he was an instructor at the College of the City of New York in Drawing, English

and Geometry. At that period his artistic leanings and capabilities were already in evidence and developed throughout his life. In the last years of his disabling sickness he utilized these artistic qualities in a practical way, applying them especially to the making of unique and original raised topographical maps of the region of Bar Harbor in connection with the Lafayette National Park Museum of the Stone Age Period, a measure which owed its inception to him.

In 1884, Doctor Abbe became surgeon to St. Luke's Hospital, retaining his connection until the time of his death. Here he developed much that was original in pioneer work, especially in surgery of the gastro-intestinal tract, spinal and cerebral surgery and particularly beautifully planned and executed plastic operations. His was the earliest and possibly the best method of treating impassible strictures of the œsophagus.

Of recent years his activities had been centred largely on the development of radiotherapy. The development of the properties of radium attracted his eager attention and he blazed the way in applying it to all manner of conditions that seemed responsive to such treatment, particularly to the malignant growths. He conducted important research work in the action of the rays and was perhaps the first to point out the different values of the several rays.

Besides his continuous activities at St. Luke's Hospital he served for varying periods as surgeon to the Babies and Roosevelt Hospitals. He was professor at the Woman's Medical College for a while and for many years one of the favorite teachers at the New York Post Graduate College.

His personality was marked by much charm and a most delightful optimism. This trait was practically illustrated when at the age of seventy he flew from London to Paris. No man had more friends and certainly none had less enemies.

He belonged to numerous noted societies and was particularly interested in the American Surgical Association, the International Surgical Association, the New York Surgical Society and especially the Practitioners' Society to which he gave innumerable and admirable contributions, both carefully considered papers and beautifully presented cases and specimens of his work, particularly models made and colored by himself of the influence of radium on malignant disease.

Doctor Abbe was founder of "The Custodianship of Rush, Jenner, Pasteur, Lister, Curie Mementos" in the Cabinet of the College of Physicians of Philadelphia. The dedication is as follows:

"There is an ethical foundation stone in the education of a medical man, which is just as essential as book knowledge, and laboratory work. The subtle power of the names which rank high in our profession, makes an impression upon the student's early manhood and unfolding character. A virile force pervades him when he has the high example of character held before him.

"There are some names in our profession, which represent our medical ancestors, as it were, whose very spirit evokes a thrill when we come into actual touch with their belongings, such as no ordinary thing inspires. The actual objects that felt the living touch of the great Pasteur, Jenner, Lister, Rush, Curie and others of like fame, are

CHARLES L GIBSON

more sacred to us than the cloak of Charlemagne or the cocked hat of Napoleon, for example. It needs not more than one verified article which was the intimate personal property of such human beings to visualize for us the whole character of the owner, and thrill the observer. Who would not glow with interest and sympathy when he sees the instruments used by Lord Lister in the early days of his work and triumph? Who would not travel a thousand miles to see and hear the immortal Pasteur, who put into action those compelling thoughts evolved out of his giant brain? Recently, in this

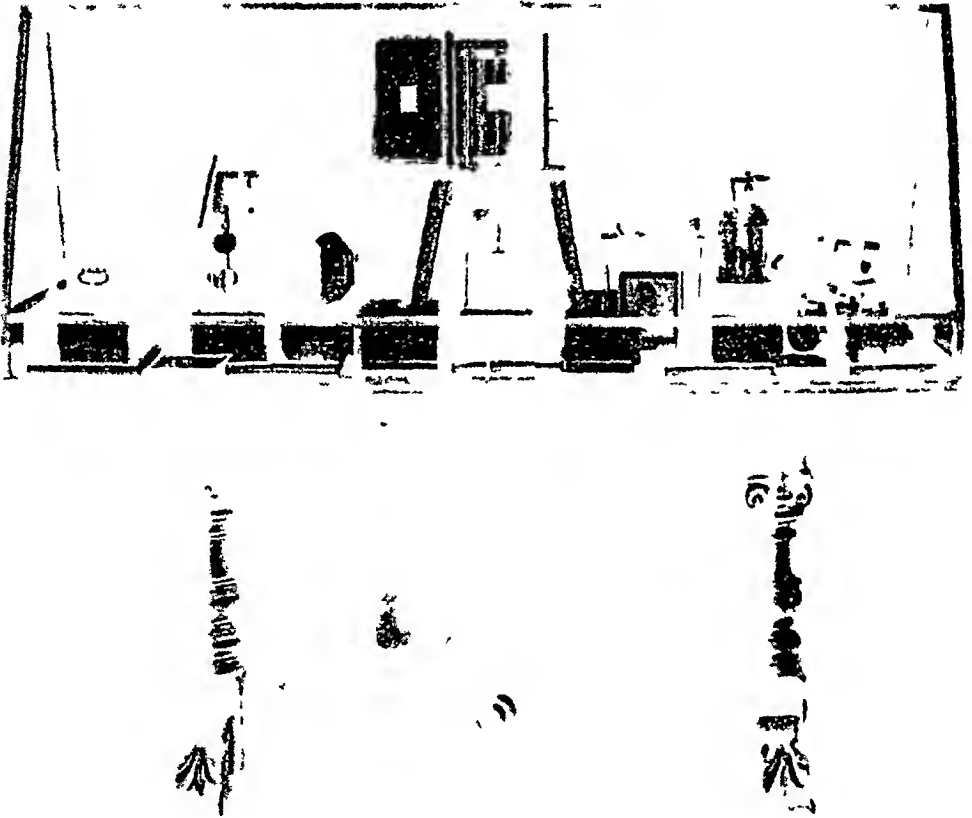


FIG. 2—Case and mementoes, with books containing portraits, illustrations, autograph letters and biographic notes, with the conditions of the custodianship. First custodian—Dr. Weir Mitchell, 1910-1917. Second custodian—Dr. Simon Flexner, New York, 1917-1920. Third custodian—Dr. William Henry Welch, Baltimore, 1920-1924. Fourth custodian—Dr. William W. Keen, Philadelphia, 1924-

decade, a new light has radiated on science from the Curie laboratory in Paris, which has not only revolutionized the conception and calculation of the forces of nature, but has put into the hands of our profession a weapon, hitherto unsuspected, to help control disease."

The purpose and contents of the cabinet were demonstrated at a meeting in honor of Madame Curie at the College of Physicians of Philadelphia in 1921 when Doctor Abbe described the origin and purpose of this custodianship —

"More than ten years ago, as you know, there was presented to me the beautiful gold watch of Dr. Benjamin Rush, one of your society's founders and a hero of Revolutionary days. It was made the subject of a custodianship to be held as an honor, by

successive members of our profession, who represented the same high qualities of mind and lifework as he did. The first custodian was Dr Weir Mitchell. He chose Dr Simon Flexner as his ideal and successor. Doctor Flexner, after three years, passed it on to Dr William H. Welch, who accepted the honor and is its present custodian, to the delight of everyone, saying 'Why! It's like the gold-headed cane'."

I saw the gold-headed cane in the College of Physicians' cabinet in London last summer, and with it were five other treasures: first, a pair of scissors belonging to Jenner and a cow's horn from one of the historic animals used in vaccination, second, a small wooden stethoscope used by Laennec, third, a short ebony pointer used by Harvey in his lectures on the blood, fourth, a small silver platter given in 1661 by the Fellows of the College, but stolen in 1666 at the looting during the great fire of London. It was lost for 250 years and was recovered at a collector's sale of old silver a few years ago.

I was inspired by this small group and by its effect upon me to think I might acquire some things worthy to add to our custodianship. My hope was of Lister, Pasteur and Curie, but from the first inquiry I was given discouragement.

Pushing my endeavors during my short stay in London and Paris, I was at last rewarded by three remarkable gifts of veritable treasures, of each great name and these I present tonight:

A box of surgical instruments used by Lord Lister

A large model of a tartrate crystal used by Pasteur

A wonderful historic instrument made by Pierre Curie, and used by him and Mme Curie in her immortal discovery of radium

These memorable souvenirs probably cannot be duplicated anywhere outside of the Lister, Pasteur and Curie museums. They were secured through the assistance of Doctor Keen and Doctor Gibson, and by the gifts of Sir Rickman J. Goode (Mr Lister's nephew), of Calmette and Roux (Pasteur's assistants and successors), and of Mme Curie herself.

In the possession of this institution there has been an inkstand of Jenner, which was given by Dr Weir Mitchell, and has been permitted to repose in this cabinet as one of the memorable souvenirs.

With these five in the cabinet are portraits of each distinguished scientist and a beautifully bound volume of historic data, biographic notes and autograph letters of each.

In addition there are the custodianship conditions and portraits of each successive custodian with his letter of nomination and acceptance."

Some four years before his death he developed a persistent anemia, possibly the result of so long continued handling of radium. He was kept alive for several years by transfusions every three weeks. He bore his sufferings with the greatest cheerfulness and would discuss optimistically and interestingly the details of his case.

Doctor Abbe was a widower and had no children.

CHARLES L. GIBSON

BRIEF COMMUNICATION

CONGENITAL BILATERAL HALLUX VALGUS

MY PURPOSE in reporting this case is three-fold—first, to call attention to a common deformity which is almost never seen in infancy, the case reported being both congenital and bilateral, second, to present illustrations, inasmuch as cases in the literature to which I have access are not illustrated, but are merely given as case reports, while none of the standard textbooks, to my knowledge, have illustrated presentations of the anomaly, third, to reopen the old discussion as to the etiology, since the infant here reported has never worn shoes, has never borne weight, and if deformed through “accidental cramping in utero” (Clarke¹) the position necessarily assumed by the fetus offers abundant opportunity for speculation

CASE REPORT—M S, age seven weeks, was brought to the Orthopedic Clinic of the Kansas City General Hospital by her mother, with the information that the great toe of each foot had been everted since birth, and did not seem to be returning to normal position. There had been no illness or injury and the child was normal in other respects. A bilateral hallux valgus, as illustrated, was present. No similar deformity existed in the immediate family.

Mouchet² in 1919 reported a case of bilateral, congenital, hallux valgus, and this is the only bilateral case in the literature so far as I can determine. In talking with several local orthopedic surgeons of wide experience I have elicited the frank statement that none has seen such a case. This fact alone would stamp the case as rare.

The illustrations speak for themselves—the photograph showing the valgus deformity of both great toes, and the roentgenogram showing the additional feature, metatarsus varus. This latter condition is quite generally conceded to be a fundamental cause of most cases of hallux valgus. That it is frequently congenital has been shown by others and is confirmed here.

As to etiology this much seems clear from the case history, *ie*, the deformity was not produced by the wearing of shoes or other impedimenta. Intrauterine pressure or cramping producing a symmetrical bilateral deformity of this nature is almost inconceivable. The presence of an accessory bone (Young³), the intermetatarsium, between the first and second metatarsals cannot be demonstrated in so young a subject. That this bone is needed to produce a varus deformity of the first metatarsal is doubtful. Indeed, that such a bone even exists, is open to debate. Ewald⁴ called attention to the congenital etiology of hallux valgus, and as a prime requisite in the mechanism of the anomaly he demonstrated the importance of metatarsus varus, due either to a twist in the shaft of the first metatarsal, or to changes at the

CONGENITAL BILATERAL HALLUX VALGUS

metatarso-cuneiform-joint The abduction of the phalanges he considered to be a secondary feature

That ill-fitting shoes have very little to do with the deformity is a point stressed by Mensor,⁵ Ewald, and a number of others, whereas Whitman, in the 1927 edition of his work on Orthopedic Surgery, states that the condi-



FIG 1—Congenital Bilateral Hallux Valgus

tion is the “direct effect of shoes too narrow, too pointed, and in some instances, too short for the foot” In rare cases, he says, it may result from rheumatism, gout, or there may be a “congenital predisposition to the deformity”

Metatarsus varus, as has been pointed out by some writers, may be an

atavistic tendency and therefore a remote or indirect cause of the hallux valgus

There is no evidence of a familial tendency to hallux valgus in the case herewith reported, but a marked tendency to inherit the proclivity toward such deformity has been noted repeatedly by orthopedic surgeons

Given a congenital metatarsus varus and a lack of reciprocal action between the flexors and adductors of the foot and first metatarsal, and the extensor longus hallucis, with the extensor longus hallucis the stronger of the two forces, and we may readily conceive of the resultant valgus deformity of the great toe



FIG 2—Congenital Bilateral Hallux Valgus at seventh week

In conclusion, basing my opinion on this case, on the literature, and on experience, I should say that hallux valgus is a congenital or acquired deformity having for its basis a congenital concomitant metatarsus varus deformity, with the valgus deformity of the great toe secondary, and due either to muscular imbalance (as was probably the case here) or to external pressure

BRIEF COMMUNICATION

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SUPPURATIVE PERICARDITIS FROM THE SURGICAL VIEWPOINT*

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THIS paper is based upon a study of the literature and a series of cases under my care at the Episcopal Hospital, and one at the Abington Memorial Hospital. It will deal with the subject of suppurative pericarditis from the surgical standpoint.

Pericarditis was known to the early writers on natural philosophy, although we have no record that Hippocrates was familiar with it. We find that Galen (131-201 A.D.) noted it in animals and characteristically made the bold deduction that man could likewise suffer from the disease.^{1, 2} But centuries elapsed between these first recorded descriptions of the disease and even the suggestion of an operation for the relief of a particular form of it, for it was not until 1649 that Riolan³ first advocated pericardiotomy for the relief of pericardial effusion, his plan being to trephine the sternum, and from this date down to 1819 numerous authorities were courageous enough to suggest and even to recommend the operation of pericardiotomy, one advocating a certain approach, another a different one, but we know of no successful operation throughout this period of one hundred and sixty-nine years. Thus, Senac,⁴ 1749, described pericardial effusion and recommended incision into one of the left intercostal spaces for its relief. Morgagni,⁵ 1761, appreciating the dangers resulting from the accumulation of fluid in the pericardium, hoped for an improvement in diagnostic means which would warrant resorting to paracentesis for its relief. Corvisart,⁶ 1806, argued that the diagnostic difficulties presented unsurmountable obstacles to the employment of any such measures. Even after Corvisart,⁷ 1811, published the modest Auenbrugger's discovery of precordial bulging and increased cardiac percussion dullness as a point in diagnosis, the diagnostic stumbling blocks stimulated Laennec,⁸ 1819, to wield his powerful influence in the argument against paracentesis. In his immortal "Traite de l'auscultation" the very year, by the way, in which he invented the stethoscope, he advised Riolan's plan of trephining the sternum. His clinical assistant, Collin (1824), interpreted the friction rub previously described by Laennec as "the squeak of the leather of a new saddle under the rider," but wrongly ascribed it to dryness of the sac.⁹

The involved problems of diagnosis, however, were not the only barriers to the early employment of surgical means of treating pericarditis. From the earliest times the heart was regarded with a certain superstitious awe, and

* Annual Oration in Surgery, read before the Philadelphia Academy of Surgery, April 2, 1928.

there was no doubt a certain degree of inherited apprehension which prevented any unnatural interference with an organ, enjoying the reputation which had been its own since Aristotle taught the doctrine of the primacy of the heart. Pioneers in this field probably treated the heart with superstitious deference, and would naturally hesitate long before interfering in any way with the "central abode of life and the soul" ¹⁰

For these reasons it is not surprising, then, to find that it was not until 1819 that the first successful pericardiotomy was performed. It is true that Desault,¹¹ as early as 1798, attempted by surgical means to evacuate what he thought was a pericardial sac full of pus, but he was unsuccessful because his diagnosis was wrong. Larrey,¹² likewise, met with failure when he performed

an operation for the same purpose by a different route, namely, the left costo-xyphoid

For many years *paracentesis* seemed to hold favor among surgeons (Jowett,¹³ 1827, Skoda and Schu¹⁴), and this was practiced by the Russians in their large and remarkable experience in hemopericardium, during an epidemic of scurvy in Cronstadt and the Baltic provinces ¹⁵. In isolated instances however, surgeons were known to

incise the pericardium. Thus, Hils

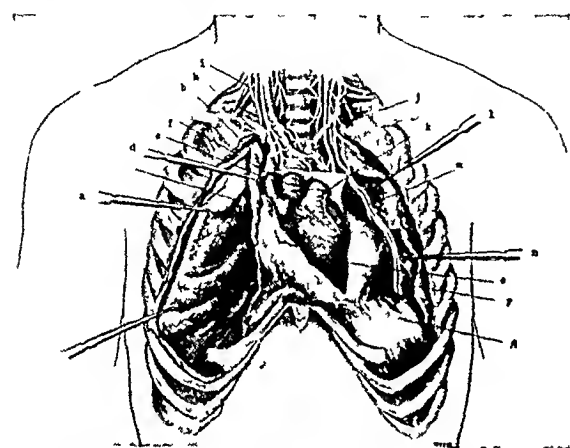


FIG. 1 — Bickham's "Operative Surgery," vol. IV, Fig. 3261, p. 2. Courtesy W. B. Saunders and Co., Philadelphia.

man,¹⁶ as early as 1844, was the first to perform pericardiotomy in a case of suppurative pericarditis, the type with which we are dealing in this paper. He incised the fourth interspace and evacuated several tumblerfuls of pus, keeping the wound patent subsequently by daily probing, with a successful result, and von Langenbeck¹⁷ operated in two similar examples of this disease in 1850. Patients suffering from non-suppurative pericarditis were operated upon many years before, however. For example, Romero,¹⁸ of Barcelona, performed the first successful pericardiotomy in 1819, having secured recoveries in two patients out of three operated upon for non-suppurative pericardial effusion.

After Trousseau and Lesague¹⁹ gave the weight of their influence to the discussion, enough cases began to accumulate to warrant collecting them in the literature, thus Gunther,²⁰ 1861, found records of twenty-two punctures, Roger,²¹ 1875, culled fourteen from the French literature, and Roberts,²² 1876, found forty-one cases to which he added thirteen new ones, Kindenberg²³ brought the total to sixty-five in 1879, and West²⁴ to seventy-nine in 1883. Delorme and Mignon²⁵ collected records of eighteen incisions and sixty-two punctures in 1895. Since then Roberts²⁶ (1897), Porter²⁷ (1900), Eliot²⁸ (1909), Rhodes²⁹ (1915), and Pool³⁰ (1921), have collected the

recorded cases of pericardiotomy for suppurative pericarditis. To Rhodes' group of eighty-six, Pool³⁰ added sixteen cases from the literature and one of his own, nine of the seventeen cases recovering. This brought Rhodes' statistics to a total of 103 cases, with fifty-four recoveries and forty-nine deaths.

I have endeavored in this paper to collect the reported cases from the literature since those given by Pool in 1921, together with several presented for the first time in this communication. I have performed pericardiotomy for suppurative pericarditis successfully in two out of three cases, and a fourth time by mistake in a case of cardiac decompensation from valvular disease. This brings the above total to 106 cases of suppurative pericarditis, with fifty-six recoveries and fifty deaths. In the cases collected from the literature since 1921, I have found records of fifteen recoveries and five deaths, making the grand total of seventy-one recoveries and fifty-five deaths.

It is interesting to pause a moment to note the prominent part played by Philadelphians in the history of pericardial surgery. One of our own members the late Dr John B. Roberts,³¹ who occupied the President's Chair in this Academy in 1906, was one of the chief American contributors. In 1876, while an interne, he searched the shelves of the Pennsylvania Hospital Library for records of pericardiocentesis, later publishing the fruits of his labor. From that time till 1923, he not only contributed valuable communications on this and related subjects, but invented and used a practical trocar for performing pericardiocentesis with a minimum of danger. The distinguished retiring President of the College of Physicians, Dr Hobart A. Hare,³¹ performed experiments in 1886-1887 showing that the deleterious effects of hemopericardium were due to distention of the sac, and, more recently an important contribution to this subject has been presented by Wood and Bradley.³²

The incidence of suppurative pericarditis is not excessively low. Its clinical frequency is given by Klose and Strauss³³ as one in every 6,000 of clinical disease, but this probably varies. Thus, there were found only three cases of suppurative pericarditis in 37,130 patients treated at a general hospital handling 6,114 bed and 31,016 dispensary cases in the year 1925-1926³⁴ although Stone³⁵ noted purulent pericarditis in 15.5 per cent of 300 patients dead of pneumonia—a figure higher than the generally accepted average.

Perhaps this variation in figures, of which the above is only an example, has its explanation in the parallel fluctuations in the number, nature and severity of the complications of pneumonia, for it is this latter disease which

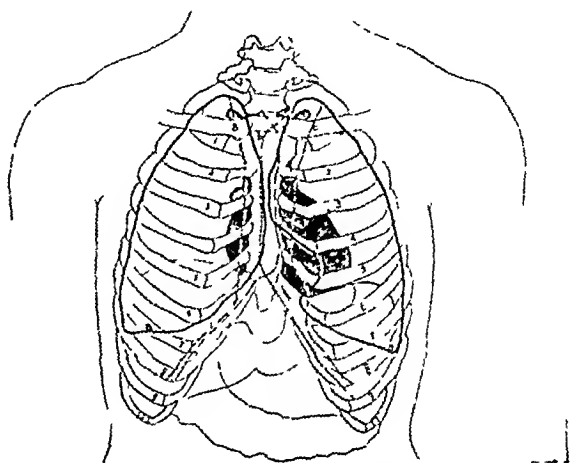


FIG. 2 — Bickham's *Operative Surgery*, vol. IV, fig. 3260 p. 2. Courtesy W. B. Saunders and Co., Philadelphia, Pa.

furnishes us with a considerable portion of pericarditis (34 per cent of Preble's cases occurred in pneumonia,³⁶ the *greatest* proportion being of the purulent form) It should not be surprising, therefore, to find that, like the mobile statistics of pneumonia, those for pericarditis reflect similar notable variations and apparent contradictions Rheumatic fever and chorea (in which suppuration is thought by some to follow the dry or plastic stage in certain instances) are perhaps of even greater importance in the etiology of pericarditis, but they occupy a far inferior rank if only suppurative cases are considered On this point the statistics are conflicting Preble,³⁶ for example, finds rheumatic fever associated with 28.36 per cent of pericarditis cases as opposed to 34 per cent for pneumonia, while Sears³⁷ noted inflammatory

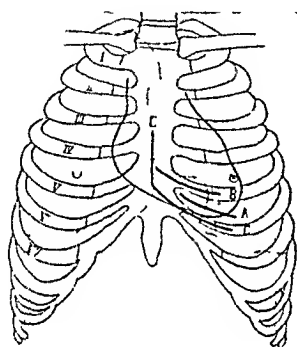


FIG. 3—"Bickham's Operative Surgery" vol. IV, Fig. 3265 Courtesy W. B. Saunders and Co., Philadelphia

rheumatism in 51 per cent of his 100 cases, and a history of previous rheumatic infection in forty others Osler,³⁸ on the other hand, found pericarditis in 6 per cent of 330 cases of rheumatic fever, and in nineteen of seventy-three chorea necropsies, while Zinn³⁹ observed pericarditis in 10 per cent of 1000 cases of rheumatism, and Sibson,⁴⁰ in sixty-three of 326 These, of course, did not all progress to the purulent stage, but some idea of the proportion of suppurative cases to those of mere effusion is given by Hedblom⁴¹ who reports 21 per cent of purulent cases in 100 effusion autopsies at the Mayo Clinic for the period of 1910-1922 It is clear from the above that the two outstanding diseases with which pericarditis is associated are pneumonia and rheumatic fever

But suppurative pericarditis may be secondary to a variety of *other infections*, such as tuberculosis,⁴² septic processes (especially of bone and puerperal fever),⁴³ gonorrhœa,⁴⁴ and it may also occur in fevers like scarlatina⁴⁵ as well as in typhoid fever³⁶ Sinnhauer⁴⁴ lists cases complicating meningitis, malaria, erysipelas, and leukemia, syphilis is a rare cause⁴⁶ One might expect to find this complication more frequently in double or right-sided pneumonia, since pneumonia on the left side is encountered less often,⁴⁷ and the bilateral disease is more severe and should therefore be expected to give a higher incidence of complications, but writers differ on this point Chatard⁴⁸ found that right-sided pneumonias are more apt to be followed by pericarditis, but Preble³⁶ maintains that the danger is greater in the left-sided affection Observers are surprised and often embarrassed to find that they have overlooked purulent pericardial exudates, as terminal complications of gout, chronic nephritis, arteriosclerosis, scurvy, pleurisy, aneurism, diabetes, and various other chronic illnesses, including certain types of hepatic cirrhosis⁴⁹ It is perhaps to the insidiousness of these curious terminal manifestations that the

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disease owes the reputation given it by Osler,⁵⁰ as probably the most commonly overlooked serious disease. In such instances, it is not found because it is not sought for, as a rule. Some of these latent cases are tuberculous.

Tuberculosis, however, is usually secondary, extending from mediastinal or tracheo-bronchial lymph-nodes, lungs, pleuræ, or as part of a general primary infection or polyserositis.¹² It is not a common cause. For example, Hedblom⁴² states that Wells found only eight cases of tuberculous pericarditis in 1048 autopsies, while Metcalf noted pericardial involvement in only 5 per cent of cases of active tuberculosis. Primary Koch's infection is much less frequent than secondary, for this same author says that Willgk found only eleven in 1317 autopsies, and that Thym noted 5.3 per cent primary in ninety-four tuberculous pericarditis cases, while Osler reports seven primary in 275.

Secondary inflammation of the pericardial sac by extension from neighboring structures also occurs, though rarely, as in exceptional cases of pneumonia, especially in children and alcoholics, simple pleurisy (rare), purulent myocarditis, aortic aneurism (rare), malignant endocarditis, from mediastinal glands, bones of the thorax, and even from the abdominal viscera.⁴⁹

The chief cause of primary pericarditis is external trauma, as in Fischer's case⁵¹ of a patient who was thrown forward, striking his chest against the steering wheel of an automobile, although the pericardium occasionally may be infected by injury from within, such as perforation of the subjacent œsophagus,⁵² or rupture of the stomach, as in Osler's case³⁸ of malignancy. Many so-called idiopathic cases are doubtless tuberculous, and others spring from tonsillitis.⁵³ That this disease is sometimes evanescent is shown by the frequency with which evidence of long standing past inflammation is found at autopsy in the guise of trivial adhesions or "milk spots"⁵⁴ in unsuspected cases. Ewart⁵³ has studied latent and ephemeral effusions which failed to attract attention because their small bulk did not elicit pain or provide conspicuous physical signs.

Pneumococci, Koch's bacillus, *Bacillus pyocyaneus*, *B. Welchii*, and various other pyogenic cocci and bacilli have been isolated from cases of purulent pericarditis.

No age group, not even in fetal life, is exempt from the disease, but the greatest frequency is between the sixth and twenty-fifth years.³³ As might be expected from its relationship with other diseases, pericarditis affects children more frequently than adults, and males more often than females (five times as often in males after the fourteenth year).³³ Pneumonia is responsible for most cases of pericarditis, not only in the age group under four years, but of *purulent* pericarditis at any age.¹⁷

McCallum's brief description of the pathology of pericarditis is so clear that I can do no better than to quote liberally from his book, as follows:⁷⁵

"Sometimes only a thin film of fibrin is exuded on the pericardial surfaces without effusion of fluid (dry pericarditis). In that case a loud creaking or rubbing sound is made by each movement of the heart. If, then, fluid appears in excess, the surfaces are held apart, and the sound is lost or cut short." When fibrin is present, "or even when the

fluid is pus-like, one may observe that, through motion of the heart, the fibrin is beaten into compact ridges which run, roughly speaking, in certain transverse and oblique lines, 'like those left by the waves on a sandy beach at low tide' "The heart is given a very shaggy appearance by this process"

"If a very great deal of fluid be exuded into the pericardial cavity, the sac is gradually dilated and will accommodate a large amount—far more than could be forced into it suddenly" "There comes a time, however, when the heart is greatly embarrassed by this fluid because it can no longer expand properly to receive the blood"

If recovery ensues it is by the formation of chronic adhesions. Close inspection will reveal the presence of tubercles in cases of tuberculous infection, where the adhesions are apt to be unusually dense.

The physical signs of pericardial effusion depend upon disturbed anatom-



FIG 4—Case I, J L before operation



FIG 5—Case I, J L after operation

ical and physiological relations resulting from the accumulation of fluid in the sac. Muffled heart sounds are characteristic, especially if these grow progressively more feeble following a gradually disappearing friction rub. This rub is presumed to vanish because the rough parietal and visceral layers of the sac whose frictions have generated it, have been separated by the intervening fluid, although the heart is usually found in contact with the anterior chest wall, even in massive effusions⁵⁶. An accumulation of 750 cc may cause the disappearance of all traces of friction rub, even at the base and apex where frictions usually linger longest, while on the other hand, the rub might still be heard in the presence of as much as a litre⁵⁷. These sounds occasionally are so elusive as to escape detection entirely, especially in the purulent variety⁴⁷. In the typical case, just as a friction rub disappears simultaneously with the accumulation of fluid in the sac, so does it reappear again as the fluid diminishes.

Increase in the area of precordial percussion dulness with alterations in its shape are among the most trustworthy diagnostic signs, although too much emphasis is probably placed on the occurrence of the pyriform shape in this area.⁴⁹ Displacement of the dull area with change in posture was noted by Skoda, and is regarded by Shattuck as of some clinical value, but Robey fails to corroborate this.⁴⁹ Rotch,⁵⁸ a former Philadelphian, for whom the Rotch sign is named, refers to extension of cardiac dulness in the fourth and fifth interspaces on the right near the sternum, a corollary to the classic obtuse cardio-hepatic angle the sign of W. Ebstein,⁵⁹ although Williamson's⁵⁶ experimental studies failed to verify the former.

Christian⁶⁰ found signs due to pulmonary compression in 73.5 per cent



FIG 6—Case II, K. S. before operation

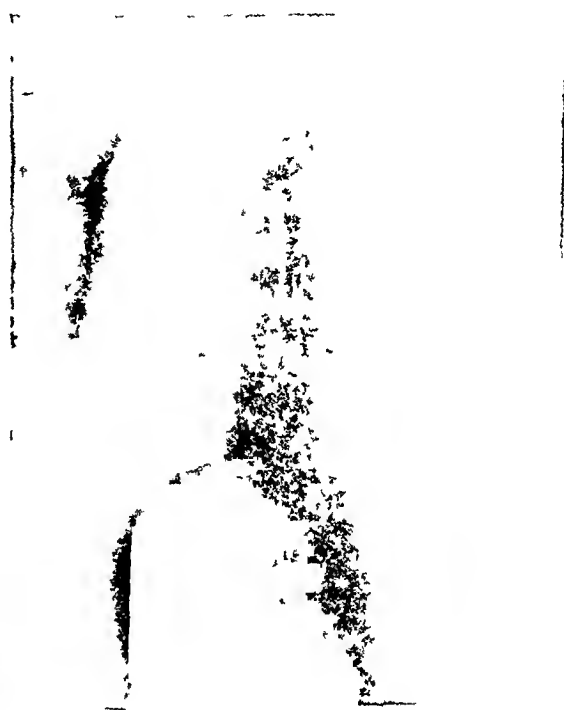


FIG 7—Case II, K. S. after operation

of his cases. Dulness at the angle of the left scapula with bronchial breathing (Bamberger) and other signs simulating consolidation are often elicited, diminished respiratory expansion on the left also belongs to this group of compression signs. Ewart⁶¹ described the invariable appearance, as a result of effusion into the pericardium, of "a patch of dulness of definite size, shape and situation at the posterior thoracic base, and its disappearance step by step with that of the fluid—this area is localized in the interval between the tenth and twelfth ribs close to the spine." It is sometimes possible to palpate the first rib on the left as far inward as the sternal articulation, in cases where the left clavicle has been raised from the underlying rib as a consequence of great respiratory activity in the upper part of the chest, embarrassed by a large effusion (Ewart's first rib sign).

Children are apt to show precordial bulging with enlargement of the entire left chest and prominence of the interspaces, while pressure exerted below through the diaphragm gives rise to swelling in the epigastrium. Downward

displacement of the liver, especially the left lobe, is regarded as the most constant early sign by Williamson,⁵⁶ who states that a 500 c c to 600 c c effusion causes a 2.5 cm displacement

Gradual diminution of the cardiac impulse may not always be present, for the heart often remains in contact with the anterior chest wall. On the other hand, the apex beat will be found to lie an undue distance medial to the left border of dulness, which is very sharply defined. Occasionally the apex beat, instead of disappearing, will extend as a wavy impulse through two or three interspaces.

A profusion of other signs have been described, but most of these are of more academic than of practical interest. To this class belongs the pulsus paradoxus, flushing of the face and neck with distention of the veins, and early accentuation of the pulmonic second sound.⁴⁹ Pulsation of the cervical vessels is sometimes as striking as that seen in aortic regurgitation (Stokes, Huchard). Fluctuation can never be elicited, probably because of the rigidity of the chest wall. Hoover's sign⁵⁷ is seen at times, limited to the lower left chest in extensive effusions, and if the effusion is purulent, the overlying chest wall may become œdematous. Some cases show a tender spot over the apex when this is pressed with the finger, and most patients seek relief by sitting up and leaning forward, a characteristic posture. Sibson⁴⁰ long ago emphasized the importance of suspecting pericardial effusion in those cases showing dulness extending above the third rib, as no other condition is said to present this sign so often.

Cardiac arrhythmias probably owe their origin partly to reflexes from distention of the sac, for Heitler⁶² was able to induce irregularities in animals by mechanical and electrical stimulation of the pericardium, and Kuno⁶³ pointed out "the mechanical influence of fluid in the pericardium on the function of the heart." The effect of general toxemia, as well as of local myocarditis, should not be overlooked as contributing to the probable cause of arrhythmias, as brought out by the electro-cardiographic studies of Yager.⁶⁴

This leads naturally to a consideration of the rôle played by instruments of precision in the diagnosis of purulent pericarditis. The use of these is subject to the same limitations as a good clinician's five senses in the diagnosis of this difficult disease. The very multiformity of the pathognomonic signs and symptoms should arouse one's suspicions of the difficulties to be expected in diagnosis, and the electro-cardiograph, X-ray, and polysphygmograph, are not exempt from the infallibility of purely human methods. Taussig⁶⁶ (1914) pointed out the inspiratory exaggeration of the diastolic notch seen in polysphygmograms, but there is nothing specific about the electro-cardiographic tracing of a case of purulent pericarditis⁶⁴ (at least nothing of this nature has as yet been discovered as far as I am aware), although such tracings may show secondary effects due to pressure toxemia and involvement of the heart muscle.

Typical roentgenograms, like typical physical signs, are easily diagnosed, but the typical cases are rare. Standard text-books on X-ray diagnosis

describe the findings somewhat as follows. They point out that the water-bottle-shaped shadow shifting with change of position of the patient is seen in no other condition except pericardial effusion. Obliteration of the normal heart shadow with widening of its base is also suggestive. Lateral views show a change in shape of the triangle formed by the posterior border of the heart, the diaphragm, and the spine—the space behind the so-called “pericardial ligament” being obliterated in most cases. Faintness or absence of pulsation may be brought out by fluoroscopic examination. These signs, of course, are not always quite satisfactorily interpretable, but the main difficulty is a clinical one and lies in the actual performance of the examination necessary for a good view. As a rule, when we rely upon the X-ray for clinching the diagnosis, the patient is too sick to be able to cooperate, nor, indeed, would it be justifiable in most instances to subject him to the necessary manipulations for either a fluoroscopic examination or for securing plates with a lateral view. Furthermore, the character of the fluid cannot be determined by X-ray.

The symptoms of this disease are legion, and in my opinion relatively unimportant because they are so apt to be misleading. The diagnosis must rest not so much on symptoms as on physical signs. Pain is not often present, but authors present widely different views on this point. Capps,⁶⁷ in a recent experimental and clinical study, concludes that the presence of pain with pericarditis usually indicates the involvement of tissues outside the pericardium, especially the pleura. Upper abdominal pain may have its explanation in the liver displacement noted previously, though its occurrence is scarcely to be wondered at considering the proximity of the diaphragm and structures beneath it to the pericardium. Russell and Kay⁶⁸ have pointed out the occasional possibility of confusing appendicitis and pericarditis and offer a possible explanation. More frequently perhaps, than actual pain, patients suffer from a sense of pericardial oppression, and tenderness over this region of the chest has already been noted. Pierson in his anatomy, suggests that this occurs because of the connection between the upper intercostal nerves and the ganglia and nerves of the intercostal plexus.

Dyspnea is usually quite marked, and there may be other symptoms referable to pressure on neighboring structures from distention of the sac, as dysphagia, aphonia, cough, and pupillary changes similar to those seen in aneurism. Irritation of the phrenic nerve may cause hiccough, paroxysmal eructations, or vomiting.⁶⁹

The general symptoms of fever, rigor, etc., need scarcely be discussed.

Diagnosis is made certain only by the finding of pus, either by exploratory puncture or by incision, but a probable diagnosis can be reached from a careful consideration of the etiology, the course of the fever, the cardiac muscle symptoms, poor general condition, precordial edema, with high leucocyte count,²⁰ together with the help of the X-ray. Possibly the chief point in the diagnosis is to suspect the occurrence of purulent pericarditis in all febrile conditions, and to attempt to rule out the disease by failing to elicit any of its

signs Only by persistent alertness in this respect can a clinician diminish this fruitful source of most embarrassing surprises at the autopsy table³³

The treatment of purulent pericarditis is drainage Whether this should be accomplished by means of multiple punctures (10.4 per cent cures), intercostal incision (37 per cent cures), or wide exposure (56.6 per cent cures) is not a matter of choice to the surgeon³³ In the face of such statistics a conscientious man is compelled to resort to wide exposure We will therefore proceed to a discussion of the operative surgery of suppurative pericarditis

It will be unnecessary to review the anatomy of the field under con-



FIG 8—Case III, R C before operation



FIG 9—Case III R C after operation

sideration, except insofar as certain points have a practical bearing on the operation

The accompanying figure (Fig 1) shows the pericardium with its relations in sufficient detail Recall that the sac lies in direct contact with the chest wall below the lowest segment of the body of the sternum, and in front of the fifth and sixth costal cartilages, and a portion of the seventh Allowing for variations, the projection of its lower limits forms a plane inclined downward toward the left, passing through the middle of the xyphoid process It terminates 5 or 6 cm from the sternal margin on the left, and its extent from the right border of the sternum is 2 cm³³ Any plan of operation designed to drain the sac must be influenced by these relations of its diaphragmatic portion, as well as by the position of the overlapping anterior margins of the pleuræ (Fig 2) While normally the anterior margin of the left pleura lies quite close enough to the sternum to render itself liable to accidental wounding during an operation here,⁷⁰ its wide variation in position makes this danger even greater, despite the fact that the pleura is reputed to move outward under the influence of a distending pericardium, or, in other instances, is said to be obliterated in the danger zone by inflammatory agglutination of its surfaces³⁰

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In view of the above facts, it is advisable to make the incision for drainage to the left of the sternum as low down as possible, for two reasons, first, because the lowermost point of the pericardium lies toward the left, and second because the sac is more likely to be uncovered by the overlapping pleura on this side.

Many operations have been devised in accordance with these principles. Kocher,⁷¹ as well as Vomitsch,⁷² resected the sixth costal cartilage, and also the two above in some cases (Fig. 3). Delorme⁷³ resected the fifth and sixth costal cartilages. Removal of part of the sternum together with the attached



FIG. 10—Case IV, M. G. before operation



FIG. 11—Case IV, M. G. after operation

sixth and seventh cartilages was the method adopted by Vomitsch⁷² and Rehn⁷³, a trap-door skin flap resection of the seventh cartilage was made by Mintz⁷⁴ and the costoxiphoid angle approach through Larrey's space⁷⁵ has also been advised. The epigastric route through the diaphragm from below (Allingham)⁷⁶ can scarcely be recommended for drainage of purulent discharges (Conitts and Rowlands⁷⁷). Pool⁷⁸ uses an S-shaped incision in the soft parts to resect the seventh, sixth and fifth costal cartilages. He points out that incision in the pericardium should be vertical to avoid striking the pleura, and that wide exposure is necessary to secure dependent drainage and to guard against the danger of encapsulation of the pus. I have found excision of the fifth and sixth costal cartilages alone to be sufficient in my own cases.

Most authorities agree that local anæsthesia is indicated. In their order of appearances, the structures met with as the incision is made are skin, fascia, the pectoralis major muscle, external intercostal membrane, cartilage and internal intercostal membrane. The internal mammary artery is either drawn outward or cut between ligatures, after which the M. Triangularis

Sterni is seen On opening this the pleura will be exposed if it is in the field Writers recommend that it should be pushed outward, although the experience of Dr John Klopp at the autopsy table leads me to believe that this is quite difficult, as he has found the pleural margins and pericardium to be quite adherent and scarcely separable without damaging one or the other Fortunately I have not encountered the pleura in my series of operations

The next structure to appear is the pericardium Before handling this in any way, it should be anæsthetized locally, as dangerous reflexes are sometimes set up by stimulation of the pericardium^{62 67 69} The pericardium is then incised vertically, using the same technic as is commonly employed in opening the peritoneum Care must be exercised to prevent rapid gushing forth of pus, for the structures involved are very sensitive to pressure changes Exploration of the entire cavity should be performed gently with the finger, as loculated collections are apt to be overlooked otherwise In one of my cases I was surprised to find a second welling forth of pus from behind the heart after I had just finished mopping up what appeared to be the entire contents of the sac While the heart is surprisingly tolerant to foreign bodies, and although some operators have used them with success, nevertheless it would appear that stiff rubber drainage tubes should not be employed The well known tendency of these drainage wounds to close too early necessitates the employment of some sort of drainage material, and because of its pliability, I have found "rubber tissue" quite satisfactory This should be carried up behind the heart

Pool recommends irrigation with Dakin's solution, post-operatively, but other authorities³³ advise only normal saline solution, if any irrigant at all is employed I have not used either in my own practice Posture will aid materially in securing proper drainage The importance of care in dressing to prevent secondary infection is paramount

I shall not discuss the general measures in the treatment, except to say that the use of Smalls serum⁷⁸ against the streptococcus of rheumatic fever might prove of value in rheumatic cases, although its originator makes no such claim for it

Cases of chronic suppuration may require subsequent extirpation of the sac, and should post-infectious adhesions develop, cardiolysis may be of benefit later This whole question, however of end-results is one in need of detailed study

Case I in my series illustrates the great difficulty in diagnosis Operation seemed quite obviously necessary in this instance, yet we found at operation that we had been mistaken in the diagnosis and that we were dealing with a dilated heart Six months after the patient's discharge from the hospital he was quite ill, with evidence of marked cardiac decompensation and a fatal prognosis was given

The frequency with which empyema is associated with suppurative pericarditis cannot fail to strike one This combination is abundantly illustrated in the series of cases appended, including one fatal case of my own (R C) Norris and Landis⁵⁷ point out the frequency with which pericarditis occurs

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secondary to streptococcic empyema, and this may account for some cases. Others, I have little doubt, are due to secondary infections of the pleura at operation, as the separation of the latter from the pericardium is quite difficult judging from observations at the autopsy table.

CASE REPORTS

CASE I—J. L., white, male, age eighteen years, admitted to the Episcopal Hospital, May 13, 1927, service of Dr. James Kay.

Chief Complaint—Dyspnoea, substernal pain, and painful joints.

History of Present Illness—This young man was admitted to the hospital with a history of having been in perfect health until three weeks before admission. At that time, while riding in a street car, he noticed when he arose from his seat that both knees and ankles were stiff, but he went about his day's work as usual without further difficulty. That same evening, however, he was seized with a sudden, dull aching pain over the entire sternum, occurring simultaneously with dyspnoea. Later that night he had definite chills followed by a fever (Temperature 101° F) and he became so ill that he had to go to bed where he remained until shortly before he was discharged from the hospital. The next day all of the above symptoms remained, but in addition he experienced very severe pain in both knees, and in the ankles these joints becoming tender, red, hot and swollen, and continued so for one week. Subsequently he had dull aching pains, much less severe, in both shoulders, the wrists and elbows, but these were fleeting in character. The dyspnoea and substernal pain diminished somewhat as the joint symptoms disappeared, but did not absolutely cease. No respiratory, gastro-intestinal nor genito-urinary symptoms.

Past Medical History—He does not recall the diseases of childhood, but states that he never had diphtheria, scarlatina or typhoid fever. Three years previously he had an acute febrile attack, accompanied by pain similar to the present, but confined to the knees and ankles and which kept him in bed for two weeks. Following this he had a tonsillectomy and adenoidectomy performed and has had no similar attacks until the present. He never had chorea. He denies and gives no direct evidence of venereal infection, and has never had any cardiac, respiratory, genito-urinary nor gastro-intestinal symptoms. His weight has been stationary. He has never had any operations, other than mentioned above, and no severe injuries.

Family History—Has no bearing on the case.

Social History—The patient was born and raised in Philadelphia, where he is an average factory worker in a Kensington textile mill. He denies the use of alcohol and tobacco, and has regular hours for sleep and meals. His living conditions are good for those of a man in his station of life.

Physical Examination—May 13, 1927. The patient was an anemic looking young white adult, sitting up in bed, with body bent forward, evidently in great respiratory distress.

The scalp, ears, nose and face were normal. No petechiae, hemorrhages, oedema, nor any discoloration were found about the eyes, and the pupils were normal in all respects. There was no evidence of pyorrhoea, but several teeth were carious. Tonsillar fossae were empty and the throat clean.

The thorax was found to be of the long narrow type, and the respiratory rate rapid (31 per minute), and shallow. No bulging of the interspaces was seen and there was no asymmetry. Percussion note, voice sounds, vocal fremitus and breath sounds were normal except in the lower third of the left chest in the mid-axillary line, where the classic signs of fluid were elicited, as well as similar signs in the lowermost 5 cm. of the right chest posteriorly. The heart rate was seventy-four per minute. The apex beat was seen and felt in the fifth interspace 10 cm. to the left of the mid-sternal line, measured circumferentially, which corresponds to the mammary line. The right border lay 3.5 cm. from the mid-sternal line. Heart sounds were distant, but a friction rub was not detected, although

a systolic apical murmur and a double aortic were heard. The abdomen and extremities presented nothing of importance.

Owing to the size and shape of the area of precordial dulness, a tentative diagnosis of pericardial effusion was made and this was confirmed by an X-ray examination performed by Dr. Ralph S. Bromer. So certain were all concerned that this boy was suffering from purulent pericarditis that operation was performed without delay under local anæsthesia (1 per cent novocaine) by Dr. E. G. Alexander. The incision, 10 cm long, was made along the left border of the sternum, resecting about 5 cm of the fifth and sixth costal cartilages. The M. triangularis sterni was then divided, and the pericardial sac anæsthetized and opened in a longitudinal direction. No fluid was found, but a tremendously enlarged heart was noted as the cause of the mistake in diagnosis. The wound was then closed in layers without drainage.

The boy's post-operative course was like that of the average acute rheumatic fever case and he left the hospital in one month with a normal temperature and no joint symptoms, but with a "decompensated" heart. Six months later he was found to be in very bad condition, with marked anasarca, dyspnoea and cyanosis, and a grave prognosis was given.

CASE II—K. S., white, male, age twenty-five years, admitted to the Episcopal Hospital, November 18, 1926, service of Dr. Ross V. Patterson.

The onset occurred five days previously and was sudden, being manifested by pain in the upper left chest, followed by a chill and high fever. Cough and rusty sputum then followed, and finally the patient became delirious. He was so ill from the very first that he had to take to his bed and remain there.

About one year previously he is said to have suffered from an attack of acute lobar pneumonia, since which time his health has remained good.

Physical examination revealed typical signs of lobar pneumonia in the right upper lobe; there was a fever of 103.8° F. The heart was enlarged (apex beat in the sixth interspace, 3 cm external to the mid-clavicular line) and its sounds were described as being somewhat distant, but no adventitious sounds were noted, nor was there anything which might lead to a suspicion of pericarditis. A diagnosis of acute upper right lobar pneumonia was made.

The day after admission the patient's temperature dropped from 104° F. to 99° F., and because of the general improvement it was surmised that the sudden fall represented a crisis. The next day, however, the temperature had risen once more to 103° F. and the respirations remained rapid (thirty-four per minute) and consequently empyema was sought for but not found. On November 23, 1926, Dr. Ross V. Patterson made the following note, in part: "Heart—impulse slight or absent, the area of deep dulness encroaches upon the superficial and Traube's space is obliterated. An area of dulness replaces the cardio-hepatic angle. Heart sounds distant. Impression—pericarditis with purulent effusion."

The above diagnosis of effusion was confirmed by X-ray, and pericardiotomy was performed the following day by Dr. E. G. Alexander. Under local (1 per cent novocaine solution) anæsthesia, an incision was made along the left border of the sternum about 10 cm long, with its centre over the fifth interspace. Through this incision the costal cartilages of the fifth and sixth ribs were excised for about 5 cm peripherally to the costo-chondral junctions and the M. triangularis sterni separated. The pericardium was then infiltrated with novocaine and incised in a longitudinal direction parallel to the skin incision, whereupon about 100 c.c. of turbid fluid was allowed to escape. This proved to be pus, but no organisms were isolated. The recovery was uneventful, and the man, when last interviewed (December 23, 1927) was found to be in excellent physical condition, presenting no evidence of cardiac disease. He works as an electrician every day and has no physical incapacity whatsoever.

CASE III—R. C., white, male, age forty-four years, admitted to the Episcopal Hospital, February 18, 1926, service of Dr. John B. Carson.

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Nineteen days previously this man was stricken with acute lobar pneumonia, and was treated for it at home by his family physician until the latter advised the family that hospitalization was necessary because of the probable development of empyema.

Physical examination on the day of admission revealed a very sick patient, presenting a "septic appearance." He showed signs of fluid at both pulmonary bases posteriorly, more marked on the left. The exact position of the apex beat could not be determined, as it extended as a wavy impulse throughout the precordial interspaces, there was an obtuse cardio-hepatic angle as well as extension of the cardiac dullness toward the left and upward as high as the second interspace. The sounds were muffled, but regular, and there were no adventitious sounds, shocks nor thrills. The white blood count was 24,320 per cu mm, polymorphonuclear leucocytes predominating. The patient's fever proved to be of the septic type, ranging between 98° F and 103° F. Dr. Ralph Bromer examined the patient roentgenologically and reported a typical shadow of pericardial effusion. On the basis of these findings a diagnosis of suppurative pericarditis was made and confirmed at operation, performed February 18, 1926, by Dr. E. G. Alexander.

Under local anaesthesia (1 per cent novocaine) an incision was made and carried along the left border of the sternum a distance of 12 cm, with its centre over the sixth costo-chondral junction, exposing the latter. About 6 cm of the fifth and sixth cartilages were then removed and the underlying triangularis sterni divided, exposing the tense pericardium heaving beneath it. A small needle was then inserted into the sac and about 20 c.c. of thin, sanguino-purulent fluid withdrawn into a syringe. The pericardium was then infiltrated with 1 per cent novocaine and incised longitudinally, whereupon 60 c.c. of a similar fluid was allowed to escape slowly. An attempt to raise the pericardium between haemostats was unsuccessful because the latter could not be made to pick up the tense sac. The aspirated fluid contained pus cells, but no organisms were found in the smear or culture. A No. 16 soft rubber catheter was then introduced behind the heart and through it 340 c.c. more of a similar fluid was withdrawn through a syringe. This catheter was then allowed to remain *in situ*, being anchored by silkworm gut sutures to the skin. Two small strips of iodoform gauze were placed in the incision on either side of the catheter and the wound was then closed around these by through and through silkworm gut sutures (interrupted). The patient was placed in a warm bed and returned to his room in fair condition, having withstood the operation quite well. He was given morphine sulphate gr. 1/6, and atropine sulphate gr. 1/150 by hypodermic injection just before operation and again several hours later, and in addition took tincture of digitalis (B. and W.) Mxx, q 4 h, alternating with spiritus frumenti ʒiiss q 4 h.

Directly after the operation a second roentgenogram of the heart was taken by Doctor Bromer, who noted a marked decrease in the density of the shadow, which was evidently thrown by the pericardial sac, as within it could be distinguished the outline of the heart. The catheter could be seen in the film.

February 19, 1926.—The patient's temperature, which was 102° F before operation fell to 98° F, but his condition remained only fair. The tube and gauze were removed from the wound. Signs of fluid now present in the lower two-thirds of the left chest. Dyspnoea marked and cyanosis set in.

February 20, 1926.—X-ray of the chest by Dr. Ralph Bromer confirmed the presence of fluid in the left chest and also showed a small amount in the right chest. The pericardium was thought to contain fluid as yet undrained. The temperature again arose to 102° F after having been normal directly after the pericardiectomy. The left chest was then aspirated through the seventh interspace in the mid-scapular line and 90 c.c. of thick greenish flakey pus obtained.

February 21, 1926.—Thoracotomy without rib resection performed at the same point as aspiration the day before, and a rubber tube placed in for drainage, similar pus was obtained. This was found to contain a diplococcus pneumoniae, not typed.

February 23, 1926—As the drainage from the pericardial wound had stopped, this was dilated by spreading with the open jaws of a hæmostat, and a rubber tube was inserted. White blood count 27,200. Polymorphonuclear leucocytes 82 per cent.

March 1, 1926—Several attempts were made since the preceding note to facilitate drainage from the pleura and pericardium, but these were not successful. Tube then removed from the pericardium. The general condition became worse and the physical signs remained unchanged.

March 4, 1926—The pericardial wound has practically healed. Tube removed from the chest. No drainage. Condition poor. Temperature has been of the septic type, its limits ranging between 98° F and 103° F. Nausea and some vomiting at times.

March 12, 1926—Gradually progressing weakness, otherwise no change.

March 15, 1926—The old pleural wound was opened again and a catheter inserted. No drainage obtained, nor did thoracentesis performed in several locations yield any pus.

March 17, 1926—X-ray by Dr Ralph Bromer shows collection of pus in the posterior mediastinum. Other collections have diminished.

April 1, 1926—The patient's condition grew progressively worse since the last note and death ensued this morning.

Autopsy Findings—Acute suppurative pericarditis, acute empyema thoracis, left, acute lobar pneumonia, right, with marked bilateral pulmonary congestion. No organisms were isolated from the pericardium, but the diplococcus pneumoniæ (type not determined) and staphylococcus aureus were obtained from the left pleura by culture, both from the specimens at previous operation and from the autopsy.

CASE IV—M G, white, female, age six years, admitted June 17, 1927, to the Abington Memorial Hospital into the service of Dr Sumner Cross, having been referred there by her family physician, Dr E E Sprenkel, with a provisional diagnosis of pericardial effusion.

Chief Complaint—Dyspnœa.

History of Present Illness—The child had been well until seven days before her admission, when she developed a frontal headache and sore throat, followed by fever (temperature 104° F) and rapid pulse (160 per minute). Three days before admission she began to show a septic type of temperature, and in spite of treatment she did not improve. She was admitted to the hospital with a temperature of 101° F (mouth), respiratory rate 60, and a pulse rate of 150 per minute.

She has had dyspnœa since the onset but no œdema or cardiac pain. No other symptoms of note were elicited from the mother's history.

Past Medical History—She never had rheumatic fever nor chorea, and only one attack of tonsillitis. She has had no operations or severe injuries.

Family History—Irrelevant.

Social History—Living conditions are good.

Physical Examination—Reveals a very alert, pale, dyspnœic, white female, of six years. The head, including the ears, eyes, nose and face show nothing abnormal. The tonsils are large and give evidence of acute inflammation, cyanosis of the lips is quite marked. No abnormal pulsations, rigidity or adenopathy were noted in the neck, and examination of the lungs reveals nothing of note.

Heart—The apex beat was seen and felt in the sixth interspace 2.5 cm lateral to the mid-clavicular line on the left. The impulse was quite diffuse. On percussion the left border of the heart was 8 cm to the left of the mid-sternal line and the right 4 cm to the right in the fourth interspace. No shocks, thrills, nor precordial bulging were present and the rhythm was normal. The rate was 150 per minute, sounds of the heart were of good quality and normal in intensity, but at the apex were both a systolic and a diastolic murmur, the former of which was transmitted to the left axilla. The pulmonic second sound was of greater intensity than the second aortic.

Abdomen—Liver dulness extended from the fifth rib to 4 cm below the right costal border in the mid-clavicular line, and the liver was tender.

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Extremities—No abnormalities noted, except pulmonary anthropathy and cyanosis of the nail beds

Genitalia, rectum and spine were normal

X-ray by Dr Donald Gulick showed an increase in the area of heart shadow not suggestive of pericardial effusion

June 20, 1927—The patient had a very uncomfortable night, suffering from dyspnoea and cough X-ray shows no change

June 22, 1927—Paroxysmal attacks of coughing and dyspnoea occurred, during which pallor and cyanosis increased, and the child perspired freely The sputum was blood tinged

June 23, 1927—X-ray showed a definite increase in the size of the heart shadow, which now presented a triangular shadow and was very suggestive of pericardial effusion

Pericardiotomy was accordingly performed by Dr E G Alexander, under local (1 per cent novocaine) anaesthesia An incision 8 cm long with its centre over the fifth interspace, was carried down the left border of the sternum, over the fifth and sixth costo-chondral junctions About 4 cm of each of these cartilages were excised and the triangular sterni fibres separated, bringing the pulsing pericardial sac into view The latter was then infiltrated with 1 per cent novocaine solution and incised carefully between hemostats in a longitudinal direction About 50 c c of turbid fluid was permitted to escape slowly This proved sterile on culture, but contained pus cells and erythrocytes in abundance, no organisms were found in the smear The wound was then closed at its upper end only, allowing the lowermost portion to remain open for drainage, and sterile dressings were applied The patient withstood the operation well and was returned to her room in no worse condition than when she left it Recovery was rapid and uneventful, and at the last report, eight months later, the child was in good health and able to take dancing lessons

CASES FROM THE LITERATURE SINCE 1921

No 1, 1926—Death Avierinos, F, and Turries, I Arch de Malad du Coeur, 1926, vol 11, pp 670-675

Italian laborer, forty-four years of age, admitted to hospital with ill-defined febrile affection, complaining of pain in right hypochondrium and dyspnoea of eighteen days' duration The onset occurred with severe precordial pain, radiating only to the upper left arm The right hypochondriac pain being present only the past four days Vertigo, sweating and fever have also been prominent

Physical Examination—Signs of left pleural effusion with muco-purulent expectoration for the past twenty-four hours Examination of the heart showed precordial dullness increased to right and left After a diagnostic exploratory puncture pericardiotomy was performed At operation very fetid, gassy pus escaped, and a drain was inserted Fifty cubic centimetres of anti-gangrene serum polyvalent were then administered intra-muscularly and the wound closed Death two hours later

Autopsy—Showed fistulous connection between pericardium and left bronchus, through which the patient was able to expectorate pus

No 2—(Not reported by Pool, 1921) Adyne-Curran, W J P, Jr Roy Army Med Corps, London, 1918, vol 11, p 599 Gunshot wound in the precordium, pyopericardium with gas infection

O W, age twenty-two years, admitted to the hospital October 9, 1916, with a wound, of entrance only, over the ninth rib, in the left posterior axillary line, having been wounded September 27, 1916

Physical Examination on October 14, 1916, showed normal precordial dullness, which on October 15, 1916, changed to complete obliteration of the precordial dull area X-ray showed distention of the pericardial sac, and a diagnostic needling was decided upon, using 2 per cent novocaine for local anaesthesia Gas was found to escape through the canula, thereby tending to confirm the previous clinical diagnosis of gas bacillus pericarditis Pericardiotomy was then performed under local anaesthesia, first excising the sixth costal

cartilage, whereby eight ounces of foul yellow pus was allowed to escape from the sac. A rubber drain was placed and the wound closed loosely about this. Convalescence was complicated by the development of pleural effusion and also phlebitis (arm). It was necessary to enlarge the draining wound under ether about twelve days post-operatively. The patient was then discharged to England in good condition February 2, 1917, and has been reported as improving since then, though his wound was still draining.

No 3—(Recovery) Bransfield, J W. *ANNALS OF SURGERY*, 1924, vol LVIII, p 293. Pericardiotomy for suppurative pericarditis.

Male, age eighteen years, complaining of pain in the left chest and dyspnoea, with a history of having run a scissors blade through the left chest two days previously. Examination showed abscess pointing over the ninth rib in the left nipple line, but incision of this failed to give expected relief of dyspnoea after evacuation of two ounces of pus. X-ray then revealed pericardial effusion confirmatory to physical signs of same. Eight days after admission pericardiotomy performed under local anaesthesia (resection of fourth costal cartilage) and one ounce fluid obtained (*Staphylococcus aureus*). Fluoroscopy performed at once showed that there was no doubt about distention of the pericardium, so that the patient was returned to the operating room and under general anaesthesia had resection of the fifth and sixth costal cartilages. Half pint of fluid escaped this time (*Staphylococcus aureus*).

Post-operative treatment consisted in daily irrigations with normal saline solution for two weeks, with drainage, after which Dakin's oil was used. By the fourth week the temperature was normal, and the patient was out of bed the fifth week. Examinations at three week intervals for four months subsequently failed to reveal any disturbance of the heart, and the X-rays were normal.

No 4, 1924—Death Despard, D L, reports the following case in discussing the above paper by Bransfield.

Man with a history of bronchitis or broncho-pneumonia past three months. X-ray revealed a dilated pericardium. Local anaesthesia. Incisions along the left border of the sternum between the fourth and seventh costal cartilages. Dakin's tubes were inserted. Two or three days later the patient's temperature rose and death ensued.

Autopsy Findings—Chronic suppurative pericarditis, tuberculous adenitis, peribronchial.

No 5, 1924—Death Dufour, H and Baruk, H. *Bull, et Mem Soc Med d'Hop de Paris*, 1924, vol XLVIII (3 S), p 744.

A patient showing septicaemia for fifteen days, followed by signs of pericardial effusion. Past twenty-four hours developed cough and fetid expectoration. Pericardiotomy performed seventeenth day of illness followed by death. Autopsy showed purulent pericardial effusion which had existed side by side with gangrenous infection of both lungs. The authors present evidence for their opinion that this represents a case of blood stream infection attacking both pericardium and lung.

No 6, 1924—(Recovery) Hall, A J, and Townrow, V. *Brit M J*, 1924, vol II, p 1148. Purulent pneumococcal pericarditis, pericardiotomy, recovery.

Male, age seventeen years, developed an acute pain in the left chest anteriorly. Three days later he became very ill and signs of pericarditis were noted. Temperature 102.8, pulse 120, respiration 40. Increase in the area of cardiac dulness, with the apex beat an undue distance medial to the left edge of dulness, together with gradually disappearing friction rub. Three hundred cubic centimetres of sero-fibrinous straw-colored fluid was withdrawn through a needle placed in the fifth interspace 4.5 cm to the left of the sternum and pneumococci were isolated from this. On the ninth day a second paracentesis was performed and 200 cc of a similar fluid withdrawn. Later, under local anaesthesia, pericardiotomy was performed, excising 2.5 cm of the fifth left costal cartilage and inserting a drainage tube behind the heart. Later, a left pyothorax was drained. The patient recovered. The authors consider paracentesis as of value in tiding patients over an unfavorable condition so that operation may follow with less risk.

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No 7, 1921—(Recovery) Hedblom, C A Surg Clin N Am, 1921, vol 1, p 1411 Primary tuberculous pericarditis

Male, age thirty-six years Onset occurred eleven months previously (May 1, 1921) with fever, sore throat and loss of weight

This was followed by an attack of bilateral phlebitis (legs) accompanied by night sweats, chest pain, and chronic non-productive cough Later dyspnoea and cyanosis developed

Physical examination showed diminished expansion on the left side of the thorax, obliteration of the cardio-hepatic angle, and distant heart sounds No murmurs No arrhythmias noted, but the vessels of the neck became suffused when the patient occupied the recumbent posture Blood pressure 108-88 mm mercury X-ray showed a large cardiac shadow A total of 2500 c c of fluid were removed by tapping the pericardium, the first of these being clear, but the last purulent Pericardiotomy was then performed with liberation of 2000 c c of fluid, and the wound was closed without drainage The fluid gave a smear positive for Koch's bacilli, but the guinea-pig inoculation was negative Two months later, a recurrence set in, as noted by symptoms and X-ray Pericardiotomy was again performed and 2000 c c of fluid removed The wound of the soft parts was closed without drainage, but this time the pericardium was left open The discharge gradually became thicker, and finally, four months after admission, the patient was discharged in poor condition

Case 8, 1926—(Death) Leys, D Lancet, vol 11, 1926, p 1004 A peculiar case of pneumopyopericardium

Male, age eleven years, admitted to the hospital, March 9, 1925, complaining of pain in the left shoulder and vomiting, both of one week's duration Physical examination showed equivocal signs of pericardial effusion On March fifteenth the patient made a striking change for the worse, and an X-ray showed gas and fluid in the pericardium Operation was then performed, excising portions of the fourth and fifth ribs through a horizontal incision in the left nipple line, exposing and then opening the pericardium A large amount of very foul pus escaped which on culture proved to contain a hæmolytic streptococcus, with B mucosis capsulatis and a gas forming anaerobe The boy survived the operation for one week discharging a large amount of pus throughout

Autopsy showed a sinus connecting the pericardium with an œsophageal diverticulum to which latter a caseous tracheal lymph gland was adherent

No 9, 1925—(Recovery) Wood, A C, and Bradley, W N Atlantic M J, 1925, vol XXVII, p 436

White male, age four years, nine months old, admitted April 8, 1923, with a history of having had rubeola three weeks previously, followed by fever, cough and pain in the abdomen and lumbar region Physicians at the patient's home made a diagnosis of probable empyema following broncho-pneumonia, for the child became distinctly worse just before he was hospitalized, and showed signs which led to this diagnosis X-ray April 9 showed a shadow in the left chest, which led to an exploratory puncture, April 12, 60 c c of serum was withdrawn through a needle in the seventh interspace posterior axillary line, and pus was obtained from a needle placed in the second interspace just outside the nipple line

April 17, as the patient's condition failed to improve, despite the establishment of drainage five days previously, the exploratory needle was again inserted into the depths of the wound and this time drew pus from the pericardial sac, as it was found to swing simultaneously with the heart beat

An X-ray showed probable pericardial effusion and operation was performed April 21

Ether anaesthesia Resection of 4 cm of the third rib reveals a bulging tumefaction, the pus-distended pericardial sac This was opened and 250 c c of yellow pus was evacuated The sac was then irrigated with warm saline solution No drainage tubes were inserted at operation but the wound was kept patent by divulsion and the sac irrigated with Dakin's solution

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April 25—A drainage tube was inserted, to remain a few days

May 3—Practically no discharge Condition good

May 12—Wound has been healed Heart sounds, rhythm and dulness normal

No 10, 1924—(Death) Brooks, R Lancet, 1924, vol 11, pp 319-20

Male, age eleven years, admitted with acute osteomyelitis of the left femur, seven days' duration Operated at once Eight days later no sign of improvement, which led to examination of the chest and revealed the presence of pleural effusion, which was tapped Turbid fluid obtained, sterile in forty-eight hours Pus ten days later (Staphylococcus aureus) Pericardiotomy Death Post-mortem Abscess of myocardium and pus in pericardium

No 11, 1924—(Recovery) Brooks, R Lancet, 1924, vol 11, pp 319-20

Male, age twelve years, acute osteomyelitis of fibula of twenty-four hours' duration Immediate operation Fourteen days later amputation became necessary because his progress was poor On the twenty-first day a metastatic abscess developed over the left humerus, seven days later a friction rub was noted, gradually disappearing subsequently Cardiac dulness increased simultaneously, twelve hours later pericardiocentesis followed by pericardiotomy A rubber drainage tube was left *in situ* Staphylococcus aureus was isolated from the pus which came a few hours later Recovery uneventful

No 12, 1924—(Recovery) Brooke, R Lancet, 1924, vol 11, pp 319-20

Male, age eleven years, developed acute osteomyelitis of the right tibia, for which he was operated upon, eight days later a friction rub was detected On the twelfth day the pericardium was tapped and turbid fluid obtained (Staphylococcus aureus) Pericardiotomy Recovery uneventful

No 13, 1923—(Recovery) Gamberini C Arch Ital di Cœur, 1923, vol vi, p 619

Male, age seven years, presented evidence of suppurative pericarditis, confirmed by pericardiocentesis Subsequent frequent multiple punctures were unsuccessful and pericardiotomy was performed with excellent result, except for slight thoracic deformity

No 14, 1921—(Recovery) Rouvillois, H Bull et Mem Soc de Chir de Paris, 1921, vol XLVII, p 1117 Tuberculous pericarditis treated and cured by pericardiotomy without drainage

No 15, 1926—(Recovery) Westerborn, A Upsala Takaref Fork, 1926, vol XXXI, pp 609-622

S E, sixteen years of age, was admitted to the hospital, March 28, 1926, with a history of pain beneath the right nates and a fever On admission his temperature was 40.3° C, and physical examination revealed the presence of a carbuncle beneath the right nates, and which was incised the following day On the fifth day a pericardial friction rub was detected, and five days later there were signs of pericardial effusion, confirmed by X-ray Yellowish pus containing staphylococci was removed on April 7 and again on April 17 and May 5 On May 8 a pericardiotomy with drainage was performed under local anaesthesia, using the left costo-xiphoid angle incision with resection of the sixth and seventh costal cartilages During the operation the left pleura was wounded Convalescence was complicated by pleural effusion, but on July 31 the man was discharged cured

Nos 17 and 18—(Recovery) Bressot Lyon Chir, 1925, vol XLII, p 747, reports two cases of tuberculous pericarditis treated by pericardiotomy

No 19, 1921—(Recovery) Duguet Bull et Mem Soc de Chir de Par, 1921, vol XLV, p 1111 A report of a case of tuberculous pericarditis treated successfully by pericardiotomy

No 20, 1927—(Recovery) Ramond, L, and Weill-Spire, R Bull et Mem Soc Med d Hop de Par, 1927, vol XLIII, p 1163

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PULMONARY ABSCESS—AN EXPERIMENTAL STUDY[†]

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THE etiology of pulmonary abscess has been the topic of much recent discussion. One view in the mechanism of pulmonary abscess etiology is that infected emboli are lodged in the lung and produce abscesses. Cutler¹ and his co-workers produced experimentally such abscesses by injecting infected emboli into the jugular vein. In spite of these striking experimental results, clinical evidence would lead one to believe that pulmonary abscesses are commonly produced as a result of aspiration of infected materials into the lung. In a study of the effects of anaesthesia on aspiration, Lemon² found that aspiration of mucus and other substances occurs in the lung during the course of a general anaesthetic. When, however, the head of the animal was 28.75 cm. lower than the feet aspiration did not occur in his animals. In the discussion of Lemon's paper, Hedblum³ called attention to the fact that "pulmonary infection in man following aspiration must depend largely upon the nature or the virulence of the infective organisms or both."

Myerson,⁴ in a bronchoscopic study of one hundred cases undergoing tonsillectomy under light general anaesthesia, found that the abolition of the cough reflex is of great importance in aspiration. In seventy-eight out of 100 cases the cough reflex was abolished and in seventy-two out of the seventy-eight he noticed blood and mucus distal to the larynx. In twenty-two out of the 100 cases the cough reflex was not abolished. In only four out of this number he noticed blood and mucus below the larynx.

That the aspirated blood reaches the alveoli very readily is proven by the work of Corper.⁵ He observed that under ether anaesthesia aspiration of fluids after instillation into the nose occurs readily in dogs and rabbits placed in the horizontal position. In the non-anaesthetized animal lying in a horizontal position, however, repeated nasal instillations did not cause aspiration. On the other hand, with the non-anaesthetized animal in the vertical posture the aspiration of fluids was easily attained in rabbits but less so in dogs, the fluid being found mainly in the lower lobes. Corper also found that particulate matter such as carbon particles are found heaped up at the points of bifurcation of the air passages with relatively little being retained in the alveoli. In another series of experiments he traced the aspirated fresh blood in the alveoli of rabbits as late as four weeks after the intratracheal injection. At the site of blood localization the presence of a distinctly palpable induration

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was noticed. This was due to a proliferative pneumonitis occasioned by the presence of blood in the finer pulmonary subdivisions. The induration was found to persist longer than four weeks.

From the bacteriologic aspect the most fruitful research in pulmonary abscess has been the study of fusospirochetes. Withington⁶ in 1898 advanced the theory that certain saprophytes were the cause of pulmonary suppuration. He quotes Babes who says "these saprophytes cannot of themselves produce gangrene but are inevitably associated with some other organism, generally the pyogenic coccus." The extensive studies of Pilot and Davis⁷ and also of Kline⁸ and his co-workers gives enough of evidence of proof that the group of organisms found in the mouth of patients with pyorrhœa alveolaris are more than harmless normal inhabitants of the mouth and very likely an etiologic factor in the production of pulmonary abscess. These organisms are known under the general name of fusospirochetes and include Vincent's spirochetes, fusiform bacilli, pyogenes, diphtheroids, and at times bacilli, particularly the bacillus influenzae. David T. Smith⁹ injected intratracheally bloody material obtained from about the teeth of patients suffering with moderately severe pyorrhœa. He obtained pulmonary abscesses in 20 per cent of his animals. He used fifty mice, forty guinea pigs, five rabbits and three dogs. Smith recovered from the pus of these abscesses organisms which were morphologically identical with those recovered from pulmonary abscess in man. He was unable to produce abscesses in his three dogs. After repeated procedures we have been able to fill in this gap with our experimental work and produce pulmonary abscesses of variable frequency depending upon the conditions present. By perfecting our technic and simulating tonsillectomy conditions, as close as possible, we obtained abscesses in over 70 per cent of our dogs.

EXPERIMENTS AND RESULTS

Sixty-seven intrabronchial injections of infected materials were performed. Abscesses were produced in twenty animals or 29.8 per cent. The highest incidence of abscess formation was noticed when fresh dog blood was mixed with sputum from a patient with a pulmonary abscess. In this series fourteen injections were performed and abscesses were found in ten dogs or 71.4 per cent. The sputum from the clinical and experimental abscesses showed the characteristic fusospirochete combination along with the pyogenic cocci, diphtheroids and Gram-negative bacilli.

Sputum from a clinical abscess was injected unmixed in seven dogs. In two out of these or 28.6 per cent abscesses were obtained.

Variable combinations of infected materials were tried, namely: Abscess contents with small pieces of tonsil, pyorrhœa scrapings with pieces of teeth, pyorrhœa scrapings with tonsil tissue, and citrated tonsillectomy blood, plain citrated tonsillectomy blood, citrated blood combined with teeth, and gastric contents injected during an abdominal operation, and plain gastric contents. In addition to these, pure cultures of staphylococcus aureus suspended in

PULMONARY ABSCESS

fresh blood and also of hæmolytic streptococcus in fresh blood were injected. It should be said in passing that it was impossible to produce any abscesses in the dogs that received only pure cultures of staphylococcus mixed with blood.

In a group of nine dogs we produced a frontal sinusitis by implanting into the sinus a cotton pledget saturated with sputum from clinical pulmonary abscess. In three out of the nine dogs or 33·3 per cent we found pulmonary abscess.

When a foreign body was implanted into the lung parenchyma it was found to be well encapsulated by a thick wall of fibrous tissue, but there was no definite abscess at the site of implantation. Foreign bodies such as agar agar, pennies, navy beans, and salted peanuts were implanted in the lung.

The dogs that showed abscess formation died or were killed from one to one hundred seven days after the experiment. The abscesses varied in size from two millimetres to ten centimetres. In three dogs the lobe containing the abscess was partly or wholly gangrenous. In some cases the abscesses perforated into the pleura and caused a fatal pleurisy with effusion. Although the mediastinal lobe was involved in most cases, abscesses were found in all parts of the lung. In one case a large abscess was found in one of the tracheal glands just below the sternum at the level of the first two ribs.

SUMMARY

Aspiratory abscess can be produced in the dog if the cough reflex is controlled sufficiently long to allow the infected liquids to settle in the alveoli. The highest percentage of abscesses occurred in dogs which received fresh blood mixed with a sputum that contained a high degree of fusospirochetes mixed with pyogenes. Pyogenic organisms mixed with blood did not cause any abscesses in our animals. A lower percentage of abscesses has been produced by the injection of gastric contents, pyorrhœa scrapings, or combinations of the above mixed with small pieces of tonsils and teeth.

It has been argued that pulmonary abscesses of aspiratory origin are connected with the bronchus and that those of embolic origin are walled off and have no communication with the bronchus. In a dog that died seven days after the injection of sputum mixed with blood we found in the lower lobe an abscess the size of a hen's egg and on careful examination we could find no communication with the bronchus.

To show how important is the abolition of the cough reflex we shall mention the following incident. In one dog we injected blood mixed with gastric contents. While the cough reflex was still present we introduced a tooth through the bronchoscope and blew it in with compressed air. Immediately afterwards the opening of the bronchoscope was covered with the thumb. When the dog coughed the tooth was blown out with such a force that the root of the tooth pierced the thumb and caused an infection of the finger.

The following table will give a graphic picture of our experiments and results.

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SUMMARY OF EXPERIMENTS

Procedure	Number of Dogs	Number of Abscesses	Per cent of Abscesses
Fresh dog blood plus abscess contents	14	10	71.4
Abscess contents	7	2	28.6
Abscess contents plus tonsil tissue	3	0	0.0
Pyorrhœa scrapings plus tooth	2	1	50.0
Pyorrhœa scrapings plus tonsil tissue—plus citrated blood	6	1	16.6
Citrated blood	5	2	40.0
Citrated blood plus tooth—plus abdominal operation	2	0	0.0
Citrated blood plus tooth—plus abdominal operation —plus gastric contents	3	0	0.0
Gastric contents	5	1	20.0
Staph aureus plus fresh dog blood	10	0	0.0
Hæmolytic streptococcus plus fresh dog blood	1	0	0.0
Experimental sinusitis—chronic	9	3	33.3
Implantation of agar agar	4	0	0.0
Implantation of penny	1	0	0.0
Implantation of navy beans	6	0	0.0
Implantation of salted peanuts	3	0	0.0
Total	81	20	24.7

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VASOMOTOR AND REFLEX SEQUELÆ OF UNILATERAL CERVICAL AND LUMBAR RAMISECTOMY IN A CASE OF RAYNAUD'S DISEASE, WITH OBSERVATIONS ON TONUS

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THE reflex changes ensuing upon sympathetic ramisection have for some years been under discussion among physiologists and surgeons. Many physiologists have been unwilling to admit that reflexes become altered following such procedures (see Forbes and his co-workers, 1926, Adrian, 1920, Cobb, 1925, etc.), while certain surgeons (Royle, 1926, 1927, Stewart, 1927, and others) have adduced strongly suggestive evidence that such changes do in fact occur. All are agreed, however, concerning the character of the vasomotor changes (see especially G. E. Brown, 1926, Adson, 1926, Adson and Brown, 1925, Davis and Kanavel, 1926). As the following case, which was studied with great care both before and after operation, seemed to throw light upon certain questions which are still unsettled, I felt that it was desirable to report it now rather than to await further collective evidence.

CASE I—P. B. B. H. Surg. Nos. 27524, 28273, 28574. Chilblains in childhood, difficult first pregnancy with emotional disturbance, excessive lactation and profuse perspiration, onset of ischemic symptoms in digits and toes after puerperium, pustule formation and gradual sloughing of terminal digits of index fingers for seventeen years, right radial periaxillary "sympathectomy" with no relief, right-sided cervical and lumbar ramisection, relief of symptoms in lower extremity, reflex changes.

Ruth M., an American housewife of forty-two, referred by Dr. C. L. Payzant of West Medford, Mass., was first admitted on October 29, 1926. She presented unmistakable symptoms of Raynaud's disease.

Clinical History (summarized from information obtained during three successive hospital entries).—There was no history of neurotic instability or of Raynaud's disease among her ancestors or in any member of the family. Patient had been married nineteen years, and had had three children with no miscarriages or stillbirths.

Onset of Present Illness.—Prior to her marriage the patient had always been a cheerful, even-tempered individual whose general health had been unusually good. Her habits were excellent and she had never smoked. There was nothing to suggest paroxysmal hæmoglobinuria. In childhood, however, her feet had been subject to chilblains, but for ten to twelve years before the onset of her present trouble she had not been so troubled. At seventeen she had had a running ear. Her present illness began four to five months after the birth of her first baby. The pregnancy had been uneventful and the patient was pleased over the prospect of having her first child. As her marital life was then and has continued a happy one, there was therefore no background of domestic discontent. However, the birth was extremely difficult, the patient having been in labor for three to four days, and when finally delivered she suffered an extensive third-degree tear. From the beginning of her confinement she had lost confidence in her obstetrician and attributed her misfortune to improper care. The puerperium lasted six weeks, during which time she ran a high fever, and for a year afterward was "worn out" and unable to take care of her child. For several months after this pregnancy she was troubled by

an excess of milk, it came in great quantities and a pump had to be used three to four times daily for a month or more in order to draw off the excess which the baby could not take. She also perspired profusely while nursing the child, and she was also subject to palpitation which was brought on by any slight excitement. Easily upset emotionally, she often wept without adequate cause, reading a tragic novel made her uncontrollably lachrymose. Emotional instability has continued without great modification until the present time. There were slight exacerbations of symptoms during her two succeeding pregnancies which occurred respectively ten and sixteen years after the first.

Symptoms of Ischæmia—About four months after her first pregnancy she noticed a sore spot on her left fore-finger which was thought to be a felon. Poulticing the finger

aggravated her symptoms. A week later the skin of the tip of the finger and also the deeper tissues sloughed off and did not heal for nearly a year. Since this first experience she has had many more sloughing pustules, involving at one time or another all of the fingers on her two hands except her two ring fingers and thumbs. Two weeks prior to her first entry her right foot had become similarly involved, though for four to five years she had noticed occasional cyanosis and blanching of both lower extremities. In the course of a day her upper extremities are ordinarily subject to repeated attacks of ischæmia. These begin with a sensation of numbness and tingling associated with marked cyanosis, which in turn is followed by blanching which may last for a half hour or more. Anything which makes her ner-



FIG. 1.—Patient's upper extremities showing marked sloughing of the terminal phalanges of both index fingers (pre-operative)

vous or excited will regularly bring on an attack of ischæmia. Thus, when Doctor Cushing showed her to a clinic, the immediate effect of the ordeal was a complete blanching of all four extremities with a sensation of numbness, and after the clinic she wept copiously and wept yet again when telling of it two days afterwards.

The patient's hands have proved to be a barometer of the weather, being much worse when cold or moist weather is impending. She always dreads the coming of winter. On a winter's morning while still in bed she feels no distress at all, but on arising her hands and feet become almost immediately blue except for the tips of her fingers which usually become dead white without initial cyanosis. Such attacks, especially those occurring in the morning, were associated with an agonizing ache of her hands, the movements incident to putting on her clothes with her hands in this state being particularly painful. She is accustomed to taking violent exercise in order to warm up her extremities, and this indeed has become a morning chore. Three or four times in the course of the day she soaks her hands in warm water, which usually relieves the pain. When her arms hang pendant she is conscious of a sensation of tightness in her fingers, and on account of this is inclined to walk and to sleep with her arms in a flexed position.

RAMISECTOMY IN RAYNAUD'S DISEASE

First Entry—*Examination* showed a somewhat irritable but healthy-looking and intelligent woman whose hands were covered with white gloves for the sake of increased warmth. Blood pressure 104/72. Urine and blood showed nothing remarkable. Heart sounds normal. Peripheral arteries not thickened and pulsation in peripheral arteries apparently normal. The only important positive findings were in her hands and feet. Proximal to the metatarsalphalangeal joints her hands appeared to be fairly normal. The fingers, however, were grossly affected, they were shiny, and the skin covering them was thin and atrophic. The nail of the right index finger had practically disappeared, evidently as a result of repeated small areas of necrosis, which the patient herself called "sore spots." At times the fingers were a deep blue with white spots on the tips of the



FIG 2 —An X ray of patient's hands showing the flattening of the terminal phalanges of index and middle fingers

fingers, at other times they were red with the same white spots present on the tips. Her hands were always cold. They did not grow pale when held up in the air, but became cyanotic when hung down. There was no sign of organic obliteration in her radial arteries. Her feet were cold, moist and clammy. Most of the toes were dead-white in color except for several which were a dark mottled blue. There was a slight swelling of the right fourth toe, the dorsal aspect of which was habitually shiny and was covered in places with scaly cornifications. This, the patient explained, was the remains of a sore spot which occurred three to four weeks before. *After hanging her legs over the edge of the bed they both became intensely blue.* X-ray of the hands showed portions of the terminal phalanges of both index fingers and of the right middle finger missing. The bones elsewhere and those of the feet were normal. Photographs of her hands and feet are shown in figures 1 and 3, and X-rays of her hand in figure 2.

During nine days' stay in the hospital the patient had daily application of Esmarch's tourniquet to her right arm, three times for three minutes at a time with about five minutes in between each application (see Cushing, 1902). After several days the "flush," on release of the tourniquet, passed rapidly down the right upper extremity to the metacarpophalangeal joint, then more slowly to the tips of the fingers. During the first days in

which the tourniquet was used, the tips of the fingers were not affected by the flush, and the patient felt that this regime had made her right hand more comfortable during the day. Doctor Cushing also prescribed a hot toddy of brandy every morning (before arising). With due allowances for mental concomitants, it was obvious to the patient and to those who examined her that the brandy diminished the frequency and severity

of her ischæmic attacks for a period of at least two hours after it was taken. She was accordingly discharged with directions to continue the tourniquet and morning hot toddies.

Second Entry—Four months later (February 24, 1927) the patient returned, and reported that though the hot toddy-tourniquet regime had made her more comfortable she was still having a great deal of pain, especially in her right arm. She was accordingly readmitted, and physical examination at this time was as before except that several new small sloughing sores had formed on her fingers (second and fifth on the right). On March 2, 1927, Dr. John Homans carried out a periarterial operation on her right radial artery. During this manipulation the artery shrunk so that no pulsation could be felt. Following the operation her skin temperatures were carefully studied with galvanometer and thermocouple. No material alteration in the



FIG 3—Patient's lower extremities before operation

temperature of her hands was made out. From subsequent observations it was evident that the operation had accomplished nothing.

Third Entry—Patient returned to the hospital for further observation on April 9, 1927, and as Dr. Norman Royle of Sydney was visiting Boston at that time, it seemed desirable to give the patient the benefit of a right-sided cervical ramisection, and Doctor Royle was accordingly invited to make the operation.

Pre-operative Examination—The patient was studied carefully by three observers prior to operation, but only such findings will be recorded here as proved of significance to her post-operative picture.

Eyes—Pupils were equal, regular, large, and reacted normally to light and to accommodation. Extra-ocular movements normal. No strabismus, ptosis or enophthalmus. Ophthalmoscopic examination showed sharply-outlined discs and unusually small arteries, in places being almost thread-like. The calibre of the retinal vessels was equal on the two sides.

RAMISECTOMY IN RAYNAUD'S DISEASE

Peripheral Pulses—Various observers noted periodic fluctuations in the amplitude of her peripheral pulses. One examiner made the following note: "Her radial and ulnar pulses are equal and full on the two sides, though from time to time their intensity varies considerably. The femoral, popliteal and posterior tibial pulses were palpable on both sides, though the posterior tibial was felt with difficulty on the right. On one occasion the right posterior tibial was not palpable at all, while on the left it was vigorous. The dorsalis pedis could not be felt at 4 P.M., April 9, though at 3 P.M. when the patient was out of bed, Doctor Homans stated that he could feel it readily, and Doctor Royle had felt it the day before. At 9 P.M., April 10, the right posterior tibial was again impalpable."

Blood Pressure—As there was some diversity of opinion concerning her blood pressure readings, they were taken on several occasions, and the same observer found them to vary from ten to twenty points even when taken in the same limb with patient prone. This was probably to be associated with the varied intensity of the pulse. There was also marked discrepancy in her blood pressure as determined in her leg and in her arm. Thus, on April 9, between 4 and 5 P.M. the following readings were obtained: right arm 100/70, 95/60, 90/45, left arm, 90/70, 80/40, 95/50. At 9 P.M., April 10, left leg (popliteal space), 160/105, 155/110, 160/100, right leg (popliteal space), 140/75, 145/80, 135/78. The arms taken immediately afterward gave the following readings: right arm, 95/60, 90/55, 98/55, left arm, 85/50 on three occasions.

Extremities—The fingers of the two hands had changed but little since the conditions described in the first entry. The middle three fingers were cold, shiny and stiff, and during ischaemic spasms looked like tallow candles. Both index fingers showed marked evidence of atrophy of the terminal phalanx with necrosis of the nail. Pain and temperature perception was greatly diminished in the terminal phalanges. It was noted in the feet that any slight manipulation tended to bring on an attack of cyanosis.

Cutaneous temperature readings with thermocouple-and-galvanometer technique were made of face, trunk and extremities before and on several occasions after operation. These findings are recorded below in Table I. It will be noted that prior to operation, temperature in corresponding points on the two sides of the body were nearly equal. Thus the average temperature of five points on the feet was 31.3 on each side (April 10th).

Reflexes Biceps, triceps, knee and ankle jerks were all equal and rather unusually active. Doctor Royle called our attention to the fact that when the patient sat on the edge of a table with her legs hanging pendant, the phase of relaxation of the jerk on each side was somewhat more prolonged than that of a normal individual under the same circumstances. The biceps jerks also were somewhat slow to relax, and by successive taps on the tendon at three to four per second the arm became completely flexed at the elbow, while in a normal individual it was not possible to produce such fusion of separate tendon responses. Kymographic records were obtained of the knee jerks, but owing to inaccuracies attendant upon records in which the inertia of the leg must be overcome, the measurements of duration of the response are of little value. Slow-speed cinematograph films were also taken of her knee jerks.

Muscular Strength—With an ergometer patient was able to squeeze 25 kilos with her right hand and 25 to 27 with her left. Power was equal in both lower extremities.

Operation (April 11, 1927, Doctor Royle and Doctor Horrax)—With the patient on her back, head rotated to the left, an incision two inches long was made just above the clavicle at an angle with it of about 45 degrees. On separation of the muscles the brachial plexus was exposed, and the rami running from the fifth, sixth, seventh and eighth trunks to the superior cervical ganglion were divided. The ramus from the first thoracic trunk were also divided. The patient was then turned on her left side with her flank elevated in the "kidney" position. Through a long incision extending from the costovertebral angle to the anterior superior spine, the latissimus dorsi was divided and the peritoneum reflected inward. The rami of the second, third, and fourth lumbar ganglia were then exposed and divided and the lower end of the sympathetic trunk was also severed.

Post-operative Course—Patient stood the operation well and made a prompt post-operative recovery. The lumbar rami were sectioned at 3 07 P M. Ether was discontinued at 3 15, and at 3 30, Doctor Cushing tested her knee jerks and observed that while the left was still brisk and prolonged, the right was noticeably brief and difficult to elicit. At 3 40 it was noted that the circulation in the right fingers appeared somewhat better than in the left, and when the finger-nail was pressed color returned in three seconds on the right and in five seconds on the left. At 3 41 *both* posterior tibial pulses were equal and ample, while immediately before operation the right posterior tibial could scarcely be felt. At 3 46 blood pressure of right arm was 108/70, left, 100/60. At 3 55 inequality of knee jerks was much more marked than at 3 40, the right being very difficult to elicit. The toes of the right foot were much pinker than those of the left. At 4 01 Doctor Royle demonstrated the difference in "tonus" of the two limbs by placing his hand in the popliteal space and raising the knee quickly. On the operated side the heel tended to drag along the operating table. On the normal side a contraction was evoked in quadriceps by the sudden elevation of the leg, and this caused the heel to be raised from the operating table for one or two seconds before it fell back. This difference between the two sides was striking and continued to manifest itself throughout her entire stay at the hospital. At 5 00 P M she was taken to the galvanometer room for readings of skin temperature on the two sides, where it was found that the temperature of her right hand was of an average of 1.5 degrees higher than that of the left. In the feet, however, a difference of 3.2 degrees was evident *just two hours after the rami had been cut* (left foot, 31.0°, right foot, 34.2°, average of five positions on each foot).

The reflex changes observed immediately after operation still persisted the next day. On testing the resting tension of her quadriceps tendon by gently moving the patella laterally, it was found that the left was much less freely movable than the right, indicating a well-marked difference in the resting tonus of the two quadriceps muscles. Patient complained of weakness in her right arm with pain in her shoulder. As later observation showed, the weakness and pain of right upper extremity increased for several days and persisted for three to four months, indicating that some of the roots of her brachial plexus had been traumatized during the operation, probably by retraction. The upper portion of her right trapezius and the belly of the supraspinatus muscle underwent noticeable atrophy, showing that the functional activity of the spinal accessory nerve had also been impaired. For a month she was able to squeeze only 5 kilos on the ergometer with her right hand, as compared with 25 to 30 in her left (and 25 in her right before operation). On June 2 she squeezed 10 kilos with her right hand, on June 22, 16 kilos, and on July 27, 25 to 29 kilos, indicating that by that time her motor power had completely returned. On September 14 she squeezed 31.5 kilos with her right hand.

Several days after operation it was observed that she had developed a marked right-sided Horner's syndrome. The right pupil was 2 mm smaller than the left, the right globe was less turgid than the left and had sunk noticeably into the orbit. On the 13th of April there was a difference of 3° in the temperature of her two cheeks, but this gradually passed off. No difference in the color of her two cheeks was noted on the record, though it may have existed.

In the preceding notes we have described briefly the immediate effects of the patient's right-sided cervical and lumbar ramisection. She was under daily observation in the hospital until discharge (April 26, 1927) after which she was seen and carefully studied at intervals of six weeks during the year. She was last seen on March 30, 1928. The findings of particular significance are those which persisted throughout the year, and we may summarize them as follows.

Circulatory Changes—The operation of ramisection was carried out primarily to improve the circulatory condition of the patient's extremities. Subjectively patient is now unaware of any difference in the temperature of her two upper extremities. She continues to wear mittens around the house and rejoices now that warm weather has once more commenced. Her fingers still become periodically blue and purple and are extremely

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tender, especially in the morning on awakening. In her lower extremities, however, she is conscious of very marked difference in temperature, the right being warmer and more comfortable. Since her operation she has had *no attacks of cyanosis or pallor of her right foot*, but she still continues to have attacks of ischæmia with marked cyanosis in her left foot five to six times a day, and whenever she sits on the edge of a chair or a table with her legs hanging pendant. The patient states that at night in bed she can always feel the difference in temperature between her two legs and warms up the left one with her right. Seven months after the operation she had a small accidental abrasion of her right inner malleolus which healed without scarring after two weeks.

Objectively (a year after operation) the circulatory condition of the two upper extremities showed no obvious difference, the color of the right being if anything a little paler than the left, and the right fingers are stiffer than the left. Radial pulses were equal on the two sides, but from time to time both varied somewhat in intensity. In her lower extremities, on the other hand, there is marked difference in color and moisture, the right being pink and dry, the left usually cyanotic and moist, especially if exposed. When patient was last seen she had, while sitting on the edge of the bed, a typical ischæmic spasm in the left foot with marked cyanosis and slight pallor at the ends of the toes. The posterior tibial pulses could be felt on both sides, but were stronger on the right, especially during the ischæmic attack of the left foot. The dorsalis pedis pulse could not be felt at all on the left and was just perceptible on the right.

Blood Pressure—Prior to patient's operation a year ago it was noted that the blood pressure of the two arms varied and a great difference in pressure was noted between the arms and the legs. This afternoon the right arm was 95/60, left 90/55, right leg 150/80, left leg 155/95. All these readings were taken with the patient lying prone with her clothes off.

TABLE I.

Temperature of Corresponding Points on Two Sides of Body Before and Shortly After Right Cervical and Lumbar Ramisection

Position	April 10 *		April 11 †		April 13 ‡	
	Right	Left	Right	Left	Right	Left
Cheek	32.4	31.4	31.9	29.6	34.4	31.6
Chest	34.1	34.4	34.1	33.1	35.1	33.1
Upper arm	32.4	32.1	33.1	31.7	31.4	29.6
Olecranon	34.2	34.2	34.8	33.6	33.4	32.9
Finger-tips 1	29.0	29.5	31.8	31.1	27.3	27.2
Finger-tips 2	27.3	27.6	32.0	30.4	27.5	27.6
Finger-tips 3	26.4	26.3	31.6	30.0	26.3	26.5
Finger-tips 4	26.5	26.0	31.8	29.6	26.0	27.3
Finger-tips 5	26.3	26.6	31.6	29.5	27.2	28.0
Palm	32.9	32.8	33.6	33.4	29.1	31.4
Dorsum hand	30.6	29.8	32.4	32.0	29.0	29.7
Knee	34.2	33.9	33.3	31.3	33.5	31.2
Instep	31.2	31.8	33.5	30.7	33.5	29.3
Inner malleolus	32.3	32.8	34.7	32.4	34.3	30.6
Outer malleolus	32.1	31.8	33.8	31.7	33.7	29.4
Dorsum foot	—	—	34.5	30.4	34.4	28.9
Great toe	30.8	30.3	34.5	29.6	34.7	27.9

* April 10 1927 24 hours before operation

† Two hours after operation

‡ Corresponding determinations were also made on April 20 and 26, with substantially the same results

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Cutaneous Temperature *—Prior to operation the temperatures of corresponding points on the two upper and the two lower extremities were approximately equal. Within two hours after operation there was a slight difference in the temperature of the two hands and a marked difference in the two feet. Illustrative values from a large number of consistent readings before and shortly after operation are given in Table I.

The following observations on skin temperature made a year after operation may be given as recorded in her clinical history.

TABLE II

Showing Approximate Equality in Temperature (in Degree Centigrade) of Corresponding Points on Two Sides of Body After Patient Had Been Covered for One Hour (March 30, 1928).

Position	Right	Left	Difference †
Forehead	33.5	33.8	0.3 L
Temple	34.2	34.8	0.6 L
Cheek	35.3	35.5	0.2 L
Clavicle	34.9	34.6	0.3 R
Chest	35.3	35.5	0.2 L
Upper arm (dorsum)	34.0	34.0	0.0
Olecranon	35.4	35.5	0.1 L
Vena cubiti	34.5	34.6	0.1 L
Lower arm (dorsum)	34.4	34.6	0.2 L
Finger-tips 1	32.2	32.1	0.1 R
Finger-tips 2	31.8	30.8	1.0 R
Finger-tips 3	30.8	30.2	0.6 R
Finger-tips 4	30.7	30.1	0.6 R
Finger-tips 5	31.9	30.2	1.7 R
Thenar	33.7	33.7	0.0
Hypothenar	34.9	34.8	0.1 L
Palm	35.0	34.8	0.2 R
Dorsum of hand	33.6	33.4	0.2 R
Knuckles 1	33.4	33.8	0.4 L
Knuckles 2	32.9	32.7	0.2 R
Knuckles 3	32.5	33.0	0.5 L
Knee	33.5	33.4	0.1 R
Calf	35.4	34.9	0.5 R
Inner malleolus	34.2	33.7	0.5 R
Outer malleolus	34.4	34.3	0.1 R
Dorsum of foot	33.5	32.8	0.6 R
Instep	34.1	33.9	0.2 R
Toes 1	34.3	33.8	0.5 R
Toes 2	34.4	33.8	0.6 R
Toes 3	34.2	33.6	1.6 R
Toes 4	33.5	32.7	0.8 R
Toes 5	32.5	32.6	0.1 L

March 30, 1928 Patient came to hospital this afternoon at 1.30 and was immediately put to bed, clad in a hospital nightgown, in the galvanometer room. The room

* All determinations were made with the thermocouple recently introduced by F. G. Benedict (1928) for study of skin temperatures. Readings can be made within six seconds of the time the metal junction is placed on a given area of skin. The apparatus was loaned to the hospital by the Carnegie Nutrition Laboratory, and I wish to record my indebtedness to Doctor Benedict for his personal supervision of the early observation and for his generous criticism of results.

† R = right higher than left L = left higher than right

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temperature at that time was 26° (Centigrade), and she was well covered and directed to keep her arms and legs under the bed clothes for an hour. She was watched through a window, and cooperated admirably. Skin temperatures were made by means of the Benedict thermocouple, as were previous determinations, and full precautions were taken to insure accurate readings of standard temperatures and equal exposure of all corresponding points which were recorded on patient's body. Readings were always made from

TABLE III

Showing Difference in Temperature of Corresponding Points on Two Sides of Body After Alcohol Rub and Exposure to Room Temperature (25°) for Ten Minutes

Position	Right	Left	Difference
Forehead	33.4	34.5	1.1 R
Temple	33.7	34.1	0.4 L
Cheek	34.6	35.1	0.5 L
Clavicle	34.1	34.3	0.2 L
Chest	35.3	34.8	0.5 R
Upper arm	32.0	31.0	1.0 R
Vena cubiti	33.7	34.0	0.3 L
Olecranon	34.0	34.3	0.3 L
Finger-tips 1	32.9	32.2	0.7 R
Finger-tips 2	31.7	28.3	3.4 R
Finger-tips 3	29.0	28.3	0.7 R
Finger-tips 4	29.5	29.8	0.3 L
Finger-tips 5	30.3	29.9	0.4 R
Thenar	32.8	33.1	0.3 L
Hypothenar	32.9	33.3	0.4 L
Palm	33.8	34.8	1.0 L
Dorsum of hand	32.5	32.8	0.3 L
Knuckles 1	32.2	33.4	1.2 L
Knuckles 2	32.8	32.2	0.6 R
Knuckles 3	32.7	32.2	0.5 R
Knee	30.8	30.2	0.6 R
Shin	32.5	31.9	0.6 R
Calf	34.4	33.6	0.8 R
Inner malleolus	31.1	31.0	0.1 R
Outer malleolus	31.4	30.2	1.2 R
Dorsum of foot	32.8	30.4	2.4 R
Instep	33.5	32.2	1.3 R
Toes 1	33.8	33.0	0.8 R
Toes 2	31.9	30.0	1.9 R
Toes 3	31.8	29.0	2.8 R
Toes 4	31.9	28.6	3.3 R
Toes 5	33.3	28.3	5.0 R

right to left, that is, a point selected for measurement on the right cheek was immediately followed within twenty seconds by readings from a corresponding point on the left cheek.

Observation 1—After patient had been well covered for an hour, readings were taken at corresponding points on the two sides of her body, as indicated in the above table. Each point was uncovered just before the reading was made, and it was observed that a fall of as much as 5° C might occur within one minute after a given point was exposed. In reading the successive finger-tips, those of the fifth finger, being last read, were colder than those of the first since they had been exposed for a somewhat longer time, but each corresponding finger on the two sides had been exposed for approximately

the same length of time when the reading was made. Because of the tenderness of patient's fingers and toes, it was found impracticable to obtain such readings from beneath the bed clothes. The absolute values obtained for a given point are indicated in Table II, the actual figures having been calculated after the observations were made.

The determinations in Table II were made between 2 35 and 3 00 P M. It is perhaps worthy of note that points on face, body and upper arm are almost exactly equal, while the finger-tips on the right are on an average .8 of a degree warmer than those on the left. Similarly the temperatures of the right foot are slightly greater than those of the left, even though patient had been covered for an hour.

Observation 2—In order to determine which side was most affected by artificially induced heat loss, patient's arms and legs were given an alcohol rub for five minutes and she was then permitted to lie exposed to room temperature for ten minutes (room temperature 25° C), and then the following series of observations were taken. It is worthy of note that when these observations were commenced the left lower extremity was slightly cyanotic, while the right continued pink.

The readings given in Table III indicate that after equal exposure of the two sides the fingers of the right hand tend to be very slightly warmer and the toes of the right foot very markedly warmer than those of the left. It is interesting that the difference in temperature of the toes is more marked for the outer toes than for the inner, corresponding points on the feet other than the toes show similar difference.

Observation 3—Patient lay prone and quiet during the first two observations. At 3 45 she was permitted to sit up on the edge of the bed so that her feet hung pendant. Five minutes later an attack of cyanosis was evident in her left foot, and in view of this readings were again taken on the toes of the two feet. In Table IV the results of these observations are given. It will be seen that there was an average of 3° C difference in the temperature of the two toes at this time, and the color difference was striking. This completed the series of thermal observations, the last being taken at 4 10 P M.

TABLE IV
Temperatures of the Toes During an Attack of Ischæmia of Left Foot

Position	Right	Left	Difference
Toes 1	30.1	26.6	3.5 R
Toes 2	27.7	24.9	2.8 R
Toes 3	28.2	25.1	3.1 R
Toes 4	28.0	25.0	3.0 R
Toes 5	30.8	25.6	5.2 R
"Ball" of foot	31.0	28.4	2.6 R

The other changes in the case which have persisted since operation may now be mentioned.

Horne's Syndrome—The right pupil has continued about 1-2 mm. smaller than the left throughout the year. A slight difference in size of the two palpebral fissures is still noticeable but enophthalmos on the right has almost entirely vanished. Except at the beginning there has been no obvious difference in the temperature of the two sides of the face, nor has there been any difference in color. On July 27, 1927, the following note was made concerning her fundi: "Careful examination showed clearly-defined disc margins and normal physiological cupping. It is quite evident, however, that there were more small arteries crossing the fundus on the left side than there were crossing the right fundus. One gained the impression that the retinal arteries on the right side were somewhat larger than those on the left." Examination a year after operation showed that this was still true, the difference being still marked, especially as regards the veins.

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In passing, we may note that the difference in size of the retinal vessels is a feature of sympathetic paralysis to which Horner (1869) called attention in his original description of the syndrome. The present case is of interest from the anatomical standpoint because only the first dorsal ramus was severed. The symptoms were definitely less marked than in cases of complete sympathetic paralysis. The pupillary constriction was perhaps as much as one would anticipate in a case of complete paralysis, but the enophthalmos was less marked and less persistent and there was no obvious vasomotor change in the face. This suggests that in this instance at least the control of the iris comes chiefly from the first thoracic ramus, and that the vasomotor control of face and conjunctivæ, normally associated with the Horner syndrome, comes from rami lower down.

Sensory Disturbances—While taking blood pressure (March 30, 1928) it was noted that compression of the right leg was much more painful to the patient than compression of the left. She remarked that since her operation the right leg had continued to be rather "tingly" and somewhat more sensitive and hyperæsthetic to touch than the left. She also remarked upon this when I was testing her knee jerk, the right patella seeming much more tender to her than the left. Such hyperæsthesia may be in some way associated with disturbance of peripheral circulation resulting from ramisection.

Another interesting sensory phenomenon is that all operative incisions have remained markedly hyperæsthetic, even though healing occurred *per primam*. The cicatrix of her periarterial incision is still exquisitely tender. This is also true of her cervical incision, but less so of her lumbar. I have no explanation to offer for this rather striking fact.

Reflex Changes—Recent discussion concerning the relation of the sympathetic system to functional activity of skeletal muscle renders the reflex changes observed in this case interesting and important. Twenty-three minutes after the lumbar rami were severed (when the first examination of her reflexes could be made) there was an obvious difference in the character and briskness of the patient's knee jerks which, immediately before operation, had been, as far as we could determine, identical. The depression of the knee jerk on the operated side, though it became less marked with the lapse of time, persisted for a year after the operation, and it is still noticeable. When the patient lies prone and the resting tension of quadriceps is tested by moving the patella laterally, it is obvious that the quadriceps on the operated side is under considerably less resting tension than on the normal side. This difference was evident even during sleep. The difference in the physiological condition of the muscles on the two sides was brought out very strikingly in the following way. When the patient was placed on a table so that her legs hung pendant, the right knee jerk, though less brisk than the left, was followed by seven or eight pendulous swings of the leg before coming to rest, while on the left side the jerks, though more ample, caused the leg to swing only two or three times before coming to complete rest. The relaxation on the left continues to be much slower than on the right. This difference between the two sides has been observed on at least twenty occasions since her operation. Moreover, when, instead of eliciting the knee jerk, the legs were lifted to a horizontal position and released suddenly, the patient's attention being at the time otherwise occupied, the right limb swung ten or twelve times before coming to rest, while the left was quiet after four or five swings. These differences have diminished slightly during the course of the year, but are still marked.

Immediately after operation the right ankle jerk was less brisk than the left, this difference has also persisted and is quite as striking as the knee jerk. It is difficult, however, to know whether there is less resting tension in the right gastrocnemius muscle than the left, for there is nothing corresponding to the patella with which to measure the resistance to previously imposed lateral deviation.

In the upper extremity the existence of a post-operative brachial neuritis for three or four months after the operation rendered comparative observations upon the biceps and triceps jerks of little value. However, after her motor power had completely recovered, as was evident on July 27, 1927, the right biceps jerks have continued during the year to be less brisk than the left, and this was true also of the response to triceps.

DISCUSSION

The Relation of the Sympathetic Nerves to Muscle Tonus—Liddell and Sherrington (1924, 1925) have given reasons for believing that the stretch reflex is the mechanism by which the tonus of skeletal muscle is maintained. In another paper the present writer (1928a) has offered clinical evidence pointing in the same direction. Since the knee and ankle jerks are fractional manifestations of the stretch reflex, they serve as indices of the tonic condition of the muscle from whose tendon they are elicited*. One may conclude, therefore, from the diminished knee jerk following immediately upon sympathectomy that the tonus of the quadriceps has been notably diminished in this case as a result of the operation. The greater tendency of the right leg to swing when hanging pendant, and the relative flaccidity of the right patella give further evidence of the same thing.

The fact that sympathectomy leads to a diminution in tonus of human beings is important and calls for comment. The same phenomenon has been observed repeatedly in well-controlled observations upon animals, notably by Kuntz and Kerper (1926), and also in man by Kuntz (1927). It is to be noted, however, that tonus *though diminished is not completely absent*, which is true also of spastic cases following ramisection (Royle, 1924, Steele, 1927). This in my opinion definitely precludes the theory that the sympathetic system governs muscle tonus. One might suggest that sympathectomy causes an increase in the threshold of the stretch reflex. Reasons have been offered elsewhere for looking upon the muscle spindles as the chief afferent end-organs of the stretch reflex (Fulton, 1926, 1928a). But alteration of the innervation of muscle-spindle's intrafusal fibres cannot well be invoked to explain the reflex changes following upon ramisection, since Hinsey (1927) and Hines and Tower (1928) have recently proved that the intrafusal fibres receive somatic innervation, and not sympathetic as some have supposed. Consequently some secondary factor such as altered blood supply or, less likely, the interruption of accessory sympathetic fibres which are supposed to supply skeletal muscle fibres, may play a rôle in producing this result. This interpretation, moreover, does not require the postulation of a vague dual mechanism of muscular activity, and it is compatible with the view, well supported experimentally, that the stretch reflex is responsible for the maintenance of muscle tonus.

Circulatory Changes—It is commonly believed that the circulatory alterations which follow upon sympathectomy gradually become compensated (see Lewis, 1927). In the present case, however, there has been very slight change in the circulatory condition of the right foot during the year, in fact the foot is about the same now as it was two hours after ramisection. The clinical condition of her hands was little affected by the operation although there has

* This generalization cannot be applied unrestrictedly, for in the spinal animal knee jerks may be present in a relatively atonic muscle. This is a somewhat special case, discussed at length elsewhere (1926, Chs XI and XXI), and does not affect the present argument.

been a slight and probably significant elevation of temperature of the right hand. The ischæmic process had evidently progressed so far on that side that removal of the sympathetic fibres was without effect. This is perhaps not surprising in an advanced case of Raynaud's disease, since in such instances the capillary walls become constricted (Lewis, 1927, p. 283) and probably fibrosed beyond repair.

The fluctuation in the blood pressure and pulse of the present case is worthy of note. On several occasions the posterior tibial pulse seemed to disappear while being palpated, and its failure ushered in an attack of cyanosis of the foot. Doctor Homans' observation that the radial artery became pulseless during manipulation is also significant. All these facts strongly suggest that the vascular spasm in Raynaud's disease involves the great vessels of the extremities as well as the small. The capillary fibrosis which eventually occurs is probably a secondary result of longstanding ischæmia.

The fact that ramisection has led to definite improvement in an extremity which had only lately become involved by the ischæmic process strongly favors the view, well supported on other grounds, that Raynaud's disease is due primarily to instability of the sympathetic vasoconstrictor centres of the extremities. Whether such factors as a constitutional tendency to abnormal agglutination of corpuscles in the peripheral capillaries* (Iwai and Meisai, 1925, 1926) also operate in the production of Raynaud's disease, must be left open. In view of the well-recognized fact that emotional disturbances tend to aggravate the symptoms in cases of Raynaud's disease, it is difficult to believe that the malady is due primarily to a defective milieu of the corpuscles. But the improvement following ramisection is not a logical objection to the

* Iwai and Meisai (1925) found that citrated blood of a patient with Raynaud's disease invariably clots if allowed to stand in a water-bath at 0° C for ten minutes, the clotting taking place no matter how vigorously the receptacle was shaken. On again warming to 31° C or higher the clot so formed redissolves. The patient's serum acted equally well on the patient's own corpuscles washed with normal saline and on the washed corpuscles of any other normal individual in a dilution of 1-1,000, but if agglutination were allowed to take place and the supernatant serum removed, it was found no longer to have any agglutinating action on the patient's cells or those of a normal control. If erythrocytes, after agglutination with patient's serum, were washed three times with normal saline at a low temperature and then with saline at 33° C, the last washing still showed the agglutinating power of the original serum. To prove that this reaction might take place equally well in a capillary vessel, the blood was run through a fine capillary loop warmed in a water bath. This it did with ease until the tube was cooled when agglutination and plugging of the tube took place, the agglutination being such as to show in the tube areas of closely clumped corpuscles separated by areas of clear serum. On warming, the corpuscles re-dissociated and the flow of blood was restored. The same phenomenon was seen in the capillaries of the patient by focusing a microscope on the patient's cornea and bathing it with saline cooled to 10° C, the agglutination being accompanied by pain. Further to prove the theory that *lowering of the temperature* alone caused the symptoms of the disease, a piece of ice was placed on various parts of the patient long enough to obtain a lowered temperature in each part tested. All regions of the body (*e.g.*, the abdomen) gave the typical picture of cyanosis and pallor so characteristic of the malady as observed in the extremities. This work has since been further confirmed by similar experiments by the same investigators on another case of Raynaud's disease (1926).

hypothesis of the Japanese workers, since increase in diameter of the peripheral vessels following constrictor paralysis would offset an abnormal tendency toward intravascular agglutination. The view of Iwai and Meisai suggests that Raynaud's disease and the Buerger's syndrome have much more in common than has previously been supposed.

Many fresh problems concerning the vasomotor control of the skin have been opened by the publication of Sir Thomas Lewis's monograph (1927) on the cutaneous blood-vessels, and this case has been analyzed as far as possible in the new light of his stimulating investigation. One must, however, await the study of further cases of Raynaud's disease before it will be possible to consider the relation of this malady to the broader problems of the normal cutaneous circulation.

SUMMARY

A case of Raynaud's disease is described in which ischæmic symptoms of the four extremities were equally advanced on the two sides of the body. A right-sided cervical and lumbar ramisection was carried out, and immediately after the operation all deep reflexes, which before had been equal, were markedly depressed on the operated side. In the right lower extremity the pulse became more full and the right foot 3° (C) warmer than the left. There was also a right-sided Horner's syndrome.

The patient has been carefully followed for a year and the altered reflexes, Horner's syndrome and thermal differences have persisted during that period. She has had no further symptoms of ischæmia in her right foot, but her right hand was not obviously benefited by the operation. There has also been a permanent and well-marked diminution of the resting tonus of her right lower extremity since the operation.

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RESULTS OF DELAY IN TREATMENT OF BREAST CANCER

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A RECENT study of cancer of the breast has been made at the Presbyterian Hospital of Chicago, under the auspices of the American College of Surgeons and in charge of Doctor Greenough of Boston One hundred cases occurring in the years 1917 to 1920 were studied in detail with after results in seventy The report of these cases will be included in a composite report of similar work done at other hospitals A brief summary of the cases which were followed through is given in the following table

Living and well	11
Alive with recurrence	1
<hr/>	
Died with recurrence	
In 1 year	9
In 2 years	19
In 3 years	13
In 4 years	6
In 5 years	2
In 6 years	1
In 7 years	1
<hr/>	
Died without recurrence	
Post-operative death	1
In 1 year	3
In 4 years	2
In 7 years	1
<hr/>	
Total	70
<hr/>	
Mortality statistics	
Seven year cures	12
Recurrences	52
Death from intercurrent diseases	6
<hr/>	
Percentage of 7 year cures	18 7

These statistics include all cases operated upon, some of which were known to be palliative None of the primary cases were refused operation

The duration of symptoms prior to medical consultation and the advice received suggested that a similar study of one hundred cases from 1924 to 1927 might be of interest The Society for the Prevention and Control of Cancer and the State Boards of Health have expended a great deal of energy in telling the people the importance of early diagnosis and prompt treatment of lumps Special emphasis has been laid on breast tumors The amount of propaganda spread through popular lectures, pamphlets, newspaper and magazine publications leaves little doubt that practically every woman knows what cancer of the breast is and the value of early surgical treatment The following figures show that progress has been made Further success is not depend-

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ent upon more extensive publicity but upon increased public confidence in the ability of surgery to cure

Duration of Symptoms Prior to Medical Consultation—In the 1917-1920 period the average delay was 86 months. Twenty-eight women consulted their physicians at once or during the first month in which the lump was noted. In the 1924-1927 series the average delay was 57 months. Thirty-five consulted their physicians during the first month of their trouble. These two hundred cases represent all classes—rich and poor, educated and uneducated—in the middle west. It is noteworthy that the privileged classes were as slow as the underprivileged in learning the truth about their breast lumps.

In the first group eleven patients delayed operation after it had been advised. Only four of the second group put off the advised operation. The majority sought medical advice only after months of personal observation had led them to believe their condition might be serious. They delayed because of fear, and because of delay lessened greatly their chances of complete eradication of the disease.

Advice Received—In the 1917-1920 period our education was far from complete. Of the one hundred women who found lumps in their breasts which at operation proved malignant, five were advised by their physicians to leave them alone. One was told to put iodine on the lumps in the axilla. Plaster applications was the sole treatment in one instance. Mastitis was the diagnosis of one lump which was operated upon three months later and which in less than two years had killed the patient with recurrences. A patient who came to the hospital with a typical Paget's disease of the breast and an underlying lump had been using salve to the sore as directed. A tenth woman had had a series of X-ray treatments which resulted in a severe burn. A medullary carcinoma involving one-half of the breast and the axillary and subclavicular lymph glands made the operation a palliative one.

Ninety women were advised promptly to have radical surgery.

We show much improvement in the diagnosis of breast cancer in the 1924-1927 period. Teaching the public to beware of lumps makes the teacher wary. Only two patients of this group of one hundred carcinomatous breasts were advised to leave alone the tumors they had discovered. A third woman of her own volition went to an osteopath and had the lump massaged. Pain and enlargement of the axillary lymph glands suggested that she consult a surgeon.

Ninety-eight per cent. received what today is considered the best advice—prompt radical surgery.

Age—The average age was 51.8 years, quite in agreement with the usual findings. The oldest was seventy-nine, the youngest twenty-two years. Fifty-seven years difference in the age of breast tissue that developed the impetus for uncontrolled cell growth.

Discussion—To secure better results in the surgery of malignancy of the breast it is clear that faith in this therapeutic measure is necessary. When the reports of happy end results have in the course of years filtered through to the laity, women will believe that surgery has something to offer besides palliation.

They will confer with their medical advisors as soon as a lump is found in the hope that a cure may still be effected. They will learn that cancer starts as a local disease and can be completely and permanently removed during that stage. The follow-up records of 375 cases investigated in England by the Manchester Committee on Cancer show that of the cases operated upon when the disease was confined to the breast seventy-two per cent were alive at the end of ten years. Of those operated upon after the disease had involved the regional lymph glands only fifteen per cent were alive at the end of ten years. When the malignancy has advanced to the regional lymph glands it is a systemic disease, and the chances for its complete eradication are slight.

In return for increased confidence shown by early consultation, as accurate a diagnosis as can be made is due every woman with breast trouble. In a woman over thirty-five a nodule, movable or fixed, a bleeding nipple, an eczema, or a localized, non-traumatic pain requires painstaking investigation. I am quoting men of wide experience when I say that every breast tumor should be removed and examined microscopically. If benign the case is closed. If malignant, grossly or microscopically, radical removal should follow at once. A tumor of the breast should be watched only when circumstances prevent its removal, and left alone only when it is not a tumor.

THE HÆMORRHAGIC DIATHESIS OF OBSTRUCTIVE JAUNDICE AND ITS TREATMENT

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DESPITE the employment of a number of remedies that have been suggested for the control and prevention of bleeding in patients with obstructive jaundice, hæmorrhage still continues as one of the important causes of post-operative mortality following surgical intervention for the relief of biliary obstruction. It is true, that even after prolonged obstruction in the extra-hepatic bile passages, a large number of patients with icterus exhibit no abnormality in the manner in which their blood clots. However, in a rather considerable number who seek surgical relief for biliary obstruction, it is found that the blood when shed does not coagulate in the usual interval. Following the employment of current methods used to combat the menace of hæmorrhage in icteric patients, the prolonged extravascular clotting time of the blood can frequently be brought to a more normal level. The occurrence of dangerous or fatal bleeding after operation in such patients, even when the pre-operative coagulation time is normal, is not unusual. Spontaneous lethal hæmorrhages in unoperated patients with obstructive jaundice are not unknown.

Within a year's time, in the Surgical Service at the University Hospital, this hæmorrhagic diathesis was observed in four patients with obstructive jaundice. One died of spontaneous hæmorrhage while being prepared for operation. Another with a markedly protracted coagulation time which remained refractory to the usual methods of reduction, died in coma after having had numerous spontaneous hæmorrhages. A third patient died of parenchymatous bleeding three days after the excision of a benign stricture from the common bile-duct, and another almost lost his life through this dreaded complication.

The first case was in the person of a man of forty-six years, with a normal pre-operative clotting time who came to operation with a jaundice of five weeks' standing. Following preparation with calcium chloride, an obliterating cholangitis was found at operation, and cholecystostomy was done. The first seven post-operative days were uneventful. Then bleeding from the wound occurred, and a hæmatoma formed. Nitrogen retention occurred. After the administration by vein of calcium chloride and oxygen and the employment of transfusions of whole blood, the hæmorrhagic tendency was controlled, and recovery followed.

In the second case the patient was a man aged sixty-six years who presented himself with a painless jaundice of six weeks' duration with marked weakness. There was no fever and a diagnosis of carcinoma of the pancreas was made. The clotting time was normal when first examined. Ten days later it was prolonged and remained so despite the employment of the usual methods.

"Fibrogen" in attempts at reduction. During the last few weeks of life, spontaneous hæmorrhages were frequent. The patient became lethargic and died in coma a little more than three months after the onset of jaundice. Multiple hæmorrhages were found. The cause of the biliary obstruction was a small carcinoma below the juncture of the cystic and common bile-ducts. No metastases were present. The ascites was due to biliary cirrhosis.

Case three was a patient whose gall-bladder had been removed previously, developed a stricture of the common bile-duct. Drainage had been omitted at the first operation. The cystic duct occlusion became insufficient and bile escaped into the peritoneal cavity causing alarming symptoms. Following the evacuation of a large quantity of bile through the operative incision, the patient had an uneventful convalescence.

The sloughing process in the cystic duct probably gradually involved the common bile-duct and biliary obstruction followed. When the patient came for examination with a jaundice of two months' duration the clotting time was prolonged. The patient went home and returned for operation a few days later. Operation (excision of the stricture and the insertion of a T-tube into the common duct) was done despite a prolonged clotting time, after calcium, transfusions, and "Fibrogen" had been ineffective for its reduction. On the third post-operative day severe hæmorrhage into the abdomen occurred and the patient died despite repeated transfusions. A limited necropsy showed the peritoneal cavity to be full of blood.

Case four was that of a woman of fifty-two years of age who came with obstructive jaundice of two months' duration. The clotting time was normal. Pre-operative preparation with calcium chloride was commenced. The patient died suddenly without premonitory symptoms or apparent cause. At the postmortem examination, extensive carcinoma of the pancreas and gall-bladder with metastases was found. Hæmorrhagic casts throughout the intestinal tract explained the sudden death.

The Cause of the Hæmorrhagic Diathesis—When the bile outflow from the liver is interrupted, retention of the biliary constituents in the blood and tissues follows. Attending this stasis, a destruction of liver tissue with marked morphological changes may ensue, together with a diminution in at least some of the functions of this important organ. An attempt will be made to evaluate the etiologic factors concerned in the genesis of the hæmorrhagic diathesis of obstructive jaundice.

1 *The Relation of Bile Retention to the Tendency to Bleed*—The belief that the retention of bile in the organism is responsible *per se* for the tendency of icteric patients to bleed is accorded wide credence. King and Stewart⁶⁴ on finding the blood calcium decreased in dogs with obstruction of the common bile-duct, suggested that calcium combined with the bile pigment in obstructive jaundice to render the pigments less toxic. King, Bigelow and Pearce⁶⁵ later substantiated this alteration in the blood calcium in dogs with biliary obstruction, but believed that the combination of bile pigment and calcium made the latter less available for the clotting process. The delay in coagulation, and the hæmorrhages of jaundice, they suggested, could be accounted for in this manner.

Cantarow, Dodek and Gordon,⁶ though believing that a functional deficiency of calcium exists in obstructive jaundice due to an increased amount of bile pigments in the blood and tissues, were unable to demonstrate any constant quantitative diminution in the blood calcium. The serum calcium in icteric patients with no delay in coagulation they found to be normal. Snell, Greene and Rowntree¹¹⁸ found that following common

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bile-duct obstruction in dogs the calcium content of the serum did not vary from the normal. Buchbinder and Kern⁸ have recently reported low serum calcium values in three cases of clinical jaundice, and in puppies with obstruction of the common bile-duct. Zimmerman¹⁴⁷ obtained normal values for calcium in the blood of patients and of dogs with obstructive jaundice, and concluded that the employment of calcium as an aid to coagulation rested on no sound theoretical basis. Kirk and King⁶⁵ have found that, whereas normally, the diffusible portion of the blood calcium is 72.3 per cent of the blood calcium, this figure may be reduced to 55.2 per cent in jaundice. Kirk and King observed similar changes in other conditions, however, in which no disturbance of coagulation occurs.

Vines^{131, 132} has found that it is the calcium in the combined state rather than the ionized portion that is necessary for the inauguration of normal blood clotting. In accordance with the suggestions of King and Stewart, and of King, Bigelow and Pearce that bile pigments combine with the blood calcium, it would appear that that portion which Vines states is necessary for clotting is increased in obstructive jaundice. The relation of calcium to the bleeding of icterus will be discussed at greater length in a subsequent section of this paper.

It is now generally conceded that, of the components of bile, the bile acids are the most toxic. However, King and Stewart,⁶⁴ of the more recent investigators dissent from this opinion and believe the bile pigments to be responsible for the toxic symptoms occasionally exhibited by patients with obstructive jaundice. The writer has discussed this question in detail elsewhere.¹³⁶ Suffice it here to say, that a constant accompaniment of biliary obstruction is the accumulation of bile pigment in the blood and tissues. If bile pigments were toxic for the organism in any degree, certainly all patients with prolonged obstructive jaundice should manifest symptoms of toxemia. As is well known, patients with biliary obstruction frequently continue in good health for a long time.

In consequence of the toxic and hæmolytic properties of the bile acids and their ability to inhibit the coagulation of blood when present in sufficient concentration *in vitro*, the origin of the hæmorrhagic tendency in jaundice is frequently attributed to them. More than twenty years ago, however, Morawitz and Bierich⁸⁶ stated that it was unlikely that the bile acids were responsible for abnormalities in the clotting of blood of patients with obstructive jaundice. They found that the addition of ox-bile to the shed blood of a dog in the dilution of one part of bile to twenty parts of blood had very little influence on coagulation. When the ox-bile was added in dilutions of 1:10 to 1:15 the coagulation of the blood was more or less delayed. The addition of one part of bile to five parts of dog's blood completely inhibited coagulation when synthetic bile salts were employed. Very little effect was obtained with dilutions of bile salts of $\frac{1}{4}$ per cent. Definite inhibition of coagulation resulted, however, when the bile salts were present in $\frac{1}{2}$ to 1 per cent dilution.

This concentration, according to Morawitz and Bierich, never occurs in the blood of patients with obstructive jaundice.

Gustav Petren⁹⁹ in a thorough study of the problem has arrived at the same conclusion. He found that the addition of either taurocholic or glycocholic bile salt in the concentration of 0.61 per cent would delay the extravascular clotting of ox-blood or of

the venous blood of hospital patients. In eighteen patients with obstructive jaundice of long standing the addition of bile salt in the same concentration was necessary to inhibit clotting. In eight other jaundiced patients, however, the delay in coagulation was obtained with an addition of bile salt in lesser concentration.

Wildegans¹⁴² anastomosed the common bile-duct to the vena cava in a number of dogs. All died after a few days, but in no instance could he demonstrate a delay in the coagulation of the blood.

Elsewhere,^{138, 139} the writer has pointed out that the excretion of bile acids is diminished following prolonged exclusion of bile from the intestine. This decrease in bile acid formation obtains when bile is lost from the body in the presence of a complete external biliary fistula as well as when the bile escapes into the peritoneal cavity following traumatic severance of the common bile-duct. After prolonged occlusion of the common duct, the synthesis of bile acids also appears to be interfered with.

Hoppe-Seyler⁶² used 30 litres of urine from a jaundiced patient to get a qualitative test for bile acids. Malkoff⁷⁸ was unable to detect the presence of bile acids in the urine of a number of icteric patients. In patients with obstruction of the common bile-duct due to malignancy, bile acids were found in the urine early in the course of the jaundice but later could not be demonstrated. Following experimental common bile-duct obstruction in the dog he observed that the bile acids usually disappeared from the urine after a short time.

Brakefield and Schmidt,⁷ in studying the excretion of bile components in dogs with obstruction of the common bile-duct found that the excretion of bile acids in the urine gradually decreased to a very small amount. Recently Snell, Greene, and Rowntree¹¹⁹ have reported quantitative determinations of bile acids in the blood of dogs following experimental obstruction of the common bile-duct. A marked increase in the bile acid content of the blood was observed on the second or third day after severance of the common duct, with maximal values during the second week of obstruction. Thereafter the bile acid in the blood was found to approach the normal level.

(Snell, Greene and Rowntree,¹¹⁹ in accordance with the view of Weintraud,¹⁴⁰ accept the explanation that a decreased synthesis of bile acid by the liver occurs following prolonged biliary obstruction. One should then rather expect values for bile acids below those observed in the normal animal when bile acid synthesis begins to fail.)

Rowntree, Greene, and Aldrich¹⁰⁰ also report quantitative bile acid determinations on patients with hepatic disease. Increased values were present early in obstructive jaundice that decreased to the normal level with long continued biliary obstruction.

It would therefore appear unlikely that the explanation of the tendency for patients with obstructive jaundice to bleed is to be found in a bile acid intoxication. The concentration of bile acids in the blood diminishes with continued biliary obstruction, whereas the tendency toward hæmorrhage is most frequently observed in those patients where the obstruction to the bile flow has been long continued.

2 *The Relation of the Liver to the Hæmorrhagic Tendency*—The important rôle of the liver in maintaining the normal coagulability of the blood has long been known. Pawlow,⁹⁴ and later Bohr,⁵ found that when the circulation above the diaphragm was shunted out of the general circulation, that blood drawn from the carotid artery about fifteen minutes later remained incoagulable. Following ligation of the celiac and mesenteric arteries in a dog, Bohr⁵ also observed that blood shed four hours later remained incoagulable for more than two hours. Some years later the same observation was made by Doyon, Morel and Kareff⁴² who found that, following the injection

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of paraffin into the celiac axis the blood when shed, failed to clot. In other dogs Doyon and Gautier,^{20, 22, 23} excised the intestines and ligated the mesenteric and celiac arteries with the same result.

In 1894, Corin and Ansiaux¹¹ had already observed that the blood of dogs poisoned with phosphorus remained incoagulable. Spontaneous hæmorrhages in the tissues of some of these animals were also seen. Doyon¹⁴ found that dogs given 25 to 50 c.c. of chloroform by stomach tube died after a few days and that blood drawn from the carotid artery shortly before death failed to clot. This alteration in the coagulability of the blood was correlated by Doyon, Morel and Billet²⁹ with the hepatic necrosis that followed the administration of chloroform, and that was responsible for the death of the animals. The same findings were present in phosphorus poisoning. More recently Kerr, Horwitz, and Whipple⁶ have found that in the liver injury attending the subcutaneous injection of phosphorus in dogs the animals die in about five days. The blood remains incoagulable and multiple hæmorrhages are usually present.

Doyon and his co-workers^{11, 14, 29} have also noted that the injection of a centigram of atropin per kilo into the mesenteric vein of a dog causes the blood to become incoagulable. Injections of atropin into the saphenous vein or into the splenic or renal artery were without effect on the coagulability of the blood. Hepatic artery injections elicited the same effect as portal injections.²⁵ Later they observed that the forcible injection of atropin into the common bile-duct had the same effect on blood coagulation as when introduced into a mesenteric vein.²⁵ In the rabbit or guinea pig, common bile-duct or mesenteric vein injections of atropin produced no alteration in blood clotting.²⁷

A gram of ox-bile per kilo injected into the mesenteric vein of a dog caused the blood to become incoagulable.²⁸ Two to three times this amount when injected into a systemic vein did not alter the coagulation of blood.³² When 1 c.c. per kilo of 10 per cent solution of taurocholic or glycocholic acid was injected into the mesenteric vein of a dog, the blood also became incoagulable. Following the injection of 5 c.c. of ox-bile into the mesenteric vein of a rabbit, the blood failed to clot when shed.³⁰ The rabbit died two hours after the injection.

The incoagulability of the dog's blood following the introduction of Witte's peptone into a systemic vein, as first observed by Schmidt-Mühlheim,⁸⁷ Doyon also attributes to an action on the liver.¹⁸ After forceful injection of Witte's peptone into the common bile-duct of a dog (0.1 gram of peptone per kilo dissolved in 30 to 40 c.c. of normal saline) a marked lowering of blood pressure accompanied by failure of the blood to clot occurred.²⁶

After excision of the liver in the dog,²⁷ and in the frog,^{21, 23} Doyon and his associates observed that the blood failed to clot. Mann and Magath⁷⁹ state that certain constant changes in the coagulation of the blood are present following hepatectomy in dogs, but do not discuss the nature of the changes observed.

These experiments indicate very definitely that destruction or injury of liver tissue and interference with or diminution of liver function may seriously alter blood coagulation. The nature of the mechanism or mechanisms by which these changes are brought about is not clear. In the alteration of coagulation observed following liver excision it would appear that something essential for blood coagulation had been removed with the liver. Doyon and his co-workers state that liver extirpation removes the source of fibrinogen. Foster and Whipple⁴⁷ in a study of blood fibrin state that all available data points to the liver as the only potential source of fibrinogen in the body. Williamson, Heck, and Mann,¹⁴⁴ on the contrary, have indicated that the liver is not necessary for the regeneration of fibrinogen.

The incoagulability of the blood in the experimental animal following mesenteric vein and common bile-duct injections of atropin, ox-bile, and bile salts and the failure to elicit this alteration after systemic vein or artery injection would indicate that some anticoagulant is liberated following liver injury. Doyon^{15 16} has found that the perfusion of an extirpated dog's liver with saline imbues the perfusion fluid with anticoagulant properties. When such a liver was perfused with the blood from another dog, the blood used also became incoagulable. Doyon¹⁶ has been able to extract anticoagulant substances from other organs and has suggested that these substances are nucleoproteins. Several years before, Conrad¹⁰ had been able to show that the pressure juice of many organs may inhibit the extravascular clotting of blood. Following the injection of thymus and liver extract of calves intravenously in rabbits, Boggs⁴ found that in many instances the blood remained incoagulable when shed.

3 *The Clinical Occurrence of the Tendency to Hæmorrhage*—Though there is no absolute correlation between the duration and intensity of icterus and the tendency of patients with obstructive jaundice to bleed, most instances that came under observation with abnormalities of coagulation have usually had biliary obstruction for some time. Of fifty-eight patients that died of hæmorrhage after operations on the biliary tract for the relief of obstructive jaundice in Swedish Hospitals, Petren⁹⁸ found that fifty had been jaundiced for three weeks or more. In only eight instances was the icterus of less than three weeks standing. The duration of jaundice was from five to eight weeks in the patients reported here. Kehr⁵⁹ refers to an instance of death from cholemic bleeding after operation when jaundice had been present only for five days.

In a previous section of this paper it has been pointed out that the retention of bile in the organism per se is probably not responsible for the tendency of icteric patients to bleed or for the alteration in blood coagulation. The explanation lies rather in the injury of liver tissue and diminution of liver function consequent upon the biliary obstruction.

The tendency to spontaneous hæmorrhage in catarrhal jaundice is practically unknown. Alteration in the manner in which the shed blood of such patients clots is also unusual. Bleeding and abnormalities of blood coagulation in patients with acute yellow atrophy of the liver,^{2 45} hepatic cirrhosis, or extensive metastasis in the liver,⁹⁰ are not unusual. Hæmorrhages following clinical poisoning with phosphorus or chloroform in which severe liver injury may occur are well known.^{58, 86}

Following jaundice of septic origin in which hepatic necrosis obtains, bleeding may also occur.^{92 115}

Mayo-Robson,¹⁰³ Arnsberger³ and Quenu¹⁰⁰ have called attention to the increased liability of patients to bleed with biliary obstruction when the obstructing mechanism is due to malignancy in the bile-ducts, over that present in patients with stone or stricture interrupting the bile flow. Quenu felt that the combination of malignancy and icterus predisposed toward hæmorrhage. Undoubtedly, the more complete biliary obstruction and consequently greater liver destruction accounts for the more frequent abnormalities

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of coagulation seen in such patients Judd and Counsellor⁶ have recently demonstrated that greater dilatation of the duct system of the liver obtains in obstruction due to carcinoma, than that seen following biliary obstruction due to stone or stricture In congenital obliteration or atresia of the bile-ducts, hæmorrhage is a frequent cause of death^{81, 120}

Petren⁹⁸ states that after operations for the relief of biliary obstruction, hæmorrhage may occur independent of age, sex, the nature of the operation performed or of the agent responsible for the block in the extra hepatic bile passages In most instances where bleeding occurred it obtained shortly following operative intervention In an instance reported here bleeding commenced seven days after operation Bleeding after the first week Petren found to be unusual Petren⁹⁸ cites a few instances, however, in which dangerous or fatal hæmorrhage occurred in patients whose jaundice had already subsided following operation

4 *The Relation of Calcium to Bleeding* Since calcium was recommended by Wright in 1891 for the control of hæmorrhage, its use has been adapted to a variety of conditions Good results attending the employment of calcium have been noted in hæmorrhages from the nose and lung as well as from hemorrhoids and after childbirth Calcium was first used in the treatment of bleeding associated with obstructive jaundice by Mayo-Robson¹⁰³ Today it is looked to as the most dependable agent in the protection against post-operative hæmorrhage in patients with obstructive jaundice

Wright stated that the coagulation of blood in hemophilia and in normal patients could be hastened by the administration of one gram of calcium chloride thrice daily Boggs¹ fed rabbits calcium chloride by stomach tube and made intravenous injections with a consistent lowering of the coagulation time Denk and Hellman¹² state that the oral administration of calcium in man increases the coagulability of the blood when the time already is normal, lower than normal, or delayed Schmerz and Wischo¹¹² injected calcium lactate intravenously in 0.10 gram doses in patients with a normal blood coagulation A shortening of the clotting time within ten minutes following the injection was regularly observed After eleven to twelve hours the coagulation time was still decreased and only returned to the initial level after 24 hours Maendl⁷ in 1920 stated that he had treated the hæmorrhages of pulmonary tuberculosis for three years with good results by the intravenous injection of 5 to 10 cc of a 10 per cent solution of calcium chloride

Van Lier⁷³ and Addis¹ have been unable to increase the coagulability of the blood in hospital patients by the oral administration of calcium Loewenstein and Politzer⁷⁴ observed no effect after giving calcium lactate by mouth, but found that the intravenous injection of calcium chloride always lowered the coagulation time even in patients in whom the blood clotted normally

Rey¹⁰² obtained consistent increases in the blood calcium of dogs following the subcutaneous and intravenous administration of calcium oxide Heubner and Rona found that the blood calcium in cats increased to two to three times normal after the intravenous injection of calcium chloride After two hours, the blood calcium was normal again Jansen³ has shown that the oral administration of only the soluble salts of calcium will increase the blood calcium Calcium bicarbonate was most effective in this respect with an increase of 57.2 per cent in the blood calcium following oral ingestion An hour or two following the intravenous injection of calcium chloride, Jansen found the calcium level in the blood normal again

The use of calcium as it is employed today in our country in the prophylaxis against hæmorrhage in obstructive jaundice, as well as when the coagulation is already delayed, has been brought about largely through the efforts of Walters^{133, 144} of the Mayo Clinic In 1921, following the intra-

venous injection of 5 cc of a 10 per cent solution of calcium chlorid once daily on three successive days as a pre-operative measure, Walters was able to report a marked reduction in post-operative mortality from hæmorrhage in obstructive jaundice. Two years later Judd and Lyons⁵⁶ reported 143 operations on the common bile-duct with eight deaths. In none of these instances, the authors state, was hæmorrhage a factor in the cause of death. More recently Judd⁵⁴ has reported 142 operations on the common bile-duct with eleven deaths. Jaundice was present in some degree in 104 patients and in four of the eleven deaths hæmorrhage was a factor in the lethal outcome. The fact that deaths occur from spontaneous hæmorrhage in patients with biliary obstruction as well as after operation upon such patients indicates, however, that the intravenous use of calcium has not solved the problem of hæmorrhage in jaundice.

The belief that the delay in coagulation and the hæmorrhagic tendency of obstructive jaundice are due to a lack of calcium in the blood has already been referred to. That the bile acids in the blood are probably not responsible for the alteration in blood coagulation has been pointed out. It has been mentioned that the retention of bile pigments in obstructive jaundice is thought to cause a functional deficiency in calcium and to render the blood calcium less available to participate in the process of blood coagulation. An actual quantitative deficiency of the blood calcium, however, does not obtain.

In parathyroid tetany in which a quantitative diminution of blood calcium occurs, no prolongation of the clotting time nor tendency to hæmorrhage obtains. Kottman and Lidsky⁶⁸ observed an accelerated coagulability of the blood in two dogs with experimental parathyroid tetany. Simpson and Rasmussen¹¹⁷ failed to observe any alteration in the coagulation of blood in experimental parathyroid tetany.

Hammarsten⁶⁰ was the first to show that in the first step in the clotting of blood, calcium was essential for the activation of prothrombin (thrombogen), into thrombin, but that the interaction of thrombin and fibrinogen to form fibrin could take place in the absence of calcium. Since then, Vines^{131, 132} has found that the presence of ionized calcium is not necessary to clotting, and Stuber and Focke¹²¹ have produced clots in the absence of calcium.

It has recently been found that following the administration of parathyroid hormone (Collip) to normal patients, or to patients with parathyroid tetany, that the blood calcium can be increased at will. Gordon and Cantarow⁴⁰ observed a consistent reduction in the clotting time following the use of parathyroid extract in patients with normal coagulation time. A change in coagulation was noted four hours after the injection and the maximum change after ten to fifteen hours. In fourteen cases of jaundice (ten obstructive) with normal blood coagulation, Cantarow, Dodek and Gordon⁶⁰ found the response to parathyroid extract injection to be similar to that observed in non-jaundiced patients. Zimmerman¹⁴⁰ tested the effect of the administration of parathyroid extract in large doses to normal dogs and after experimental bile-duct obstruction, as well as in normal patients and in patients with jaundice. An end-point for coagulation was used which for normal dogs was twenty-five minutes and for patients thirty minutes. Twenty-four to forty-eight hours later, when the coagulation time was again determined, Zimmerman observed no change from the initial reading.*

* Petren⁶⁹ used an end-point which for normal patients was thirty-eight to forty minutes. Delay in the extravascular clotting of blood by this method, when not marked, would appear to be demonstrated with greater certainty than by methods in which the usual end-point is eight minutes or less.

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Lee and Vincent⁷ state that the "calcium in vitro" test in which it is demonstrated that venous blood from jaundiced patients can be made to clot more rapidly in vitro following the addition of calcium bears evidence that there is a deficiency of available calcium in obstructive jaundice. Morawitz and Bierich⁸⁰ have also shown, however, that the same acceleration of the clotting of jaundiced blood can be brought about by the addition of tissue extract. They observed that tissue juice when added to the blood of cholemic patients in vitro caused the blood to clot three times more rapidly than normal blood.

There is, however, some evidence that would indicate a disturbance of calcium metabolism in obstructive jaundice. A number of years ago Pawlow⁸² observed that dogs with complete biliary fistula frequently developed osteoporosis. The same change was later noted in patients with biliary fistula by Seidel¹¹⁰.

The loss of calcium from the body depots and the inability to assimilate fat has been described by Duttman⁴¹ as the cause of the osteoporotic changes in bone in biliary fistula. The same loss of calcium from the body depots is said to occur in obstructive jaundice⁷⁶ and the excretion of fat in the stools is well known. King, Bigelow, and Pearce⁶³ found markedly lowered calcium values in the bones of dogs with obstruction of the common bile-duct. The osteoporotic changes described by Seidel in patients with biliary fistula have also been noted in patients with continued biliary obstruction⁷⁵.

Recently Kuttner⁶⁹ has reported parenchymatous hæmorrhages following operation in a patient with a biliary fistula of one and one-half years' duration. The bleeding responded promptly to calcium therapy.

Walters and Bowler¹²³ noted that after the intravenous injection of a given dose of calcium chloride in jaundiced dogs, that only half the increase in the blood calcium occurs that is seen following the same injection in normal dogs. The lethal dose of calcium chloride for jaundiced dogs injected intravenously was found by Walters and Bowler to be greater than for normal animals.

These facts, together with the observations of Buchbinder and Kern,⁸ and of Kirk and King,⁶⁵ previously referred to, indicate that a disturbance of calcium metabolism may be present in obstructive jaundice. The relation of this disturbed calcium metabolism to the tendency of jaundiced patients to bleed, however, is not very clear, nor does it appear to be very direct. No denial of the suggestion of Schloessmann¹¹⁰ that calcium may improve the liver function and thus lessen the liability to bleed in icterus, can be made in the present state of our knowledge concerning liver function and calcium metabolism.

A deficiency of calcium in the circulating blood of patients with biliary obstruction must not be inferred, however, because the intravenous injection of calcium chloride lowers the extravascular clotting time of the blood. It must be kept in mind that most investigators have observed a reduction in the coagulation time of the blood in normal people following calcium administration. Then, too, it is known that a number of other remedies injected into the organism may produce the same effect.

In 1904, Boggs⁴ stated that at that time gelatin was used in Germany almost exclusively to lessen the danger of hæmorrhage. Its use as a hæmostatic agent Kuster⁶⁸ says, was known to the Chinese centuries ago. It, too, like calcium has been employed with satisfaction in the treatment of hæmorrhages of many types. Kehr⁶⁷ at one time was an exponent of its use in the treatment of cholemic bleeding and reported three instances in which it was employed successfully for this purpose. Boggs⁴ obtained a lowering of the coagulation time in rabbits after intravenous or subcutaneous injections of 10 to 30 c.c. of gelatine. Gebele⁴⁸ observed a hæmostatic action following the subcutaneous injection of gelatine in animals and in man only after loss of blood had already occurred. Negative results following attempts at reduction of the coagulation time in

normal animals with gelatine are reported by Sackur¹⁰⁰ Zibell,¹⁴⁰ and Schmerz and Wischo,¹¹² attribute the influence of gelatine on the coagulation of blood to its calcium content Wildegans¹¹¹ believes that the protein in the gelatine is responsible for this action

In 1909, Von den Velden recommended the injection of 5 to 10 c.c. of a 10 to 20 per cent solution of sodium chloride as a hæmostatic, and mentions an instance of its employment with good effect in the treatment of bleeding in hepatic cirrhosis Its mode of action he thought to be entirely physical He felt that an increase in the osmotic pressure of the blood occurred resulting in a dilution of the blood by tissue fluid A decrease in the clotting time of the blood regularly followed intravenous injections of small amounts of this hypertonic solution in normal patients and animals Later Von den Velden¹³⁰ increased this dosage to 100 c.c. of a 10 per cent solution of sodium chloride for clinical use Schenck¹⁰⁸ and Bortel⁶ are inclined to believe that the beneficial action of calcium chloride in the treatment of the bleeding also occurs through this agency

Schreiber¹¹⁴ in 1913, recommended the intravenous injection of 200 c.c. of a 20 per cent solution of glucose solution for the same purpose Kehr⁶⁰ was a strong advocate of its employment in the treatment of hæmorrhage of obstructive jaundice

Weil¹³⁰ has employed and recommended the subcutaneous injection of human serum and of the serum from ox-blood in the treatment of hæmorrhagic conditions Perthes⁷ during the same year stopped the bleeding following the extraction of teeth in a hæmophilic by the injection of rabbit's blood about the bleeding surface Quenu¹⁰⁰ has followed Weil's suggestion for the treatment of the hæmorrhagic diathesis of biliary obstruction and describes good results Willy Meyer⁸² has employed the subcutaneous injection of human serum in the treatment of bleeding in jaundice and has found this procedure effective

Fonio¹⁰ has prepared and used an extract containing the lipoids and blood platelets of blood in the treatment of bleeding of every type with satisfactory results

In 1920,¹²² after the exhibition of calcium and other hæmostatic remedies had been without result, Stephan radiated the spleen and successfully arrested hæmorrhage in a patient who had bled following the removal of a supra-clavicular lymph-node He later observed that the blood of a normal patient clotted more quickly in vitro after radiation of the spleen¹²³ Schinz¹⁰⁶ noted an acceleration of the extravascular clotting of blood following radiation of the spleen in normal persons but found it ineffective in the bleeding of jaundice Tichy¹²⁷ has noted decrease of the clotting time following radiation of the liver Szenes¹³⁰ noted a shortening of the coagulation time following radiation of a malignant tumor of the thyroid Muller⁸⁸ states that the same effect may be obtained following radiation of any organ and attributes the mode of action to tissue destruction Nigst⁶¹ observed a decrease in the coagulation time after radiation of the splenic area in three patients from whom the spleen had previously been removed

The observation of Foster and Whipple's¹⁷ that radiation of the thorax or abdomen results in a prompt rise in the blood fibrin value is the likely explanation of the influence of radiation on blood coagulation The tissue injury or destruction following radiation gives rise to an increased blood fibrin

The value of blood transfusions in the treatment of all hæmorrhagic diatheses is well known and needs no special discussion here Pendl⁹³ and Pallin⁹³ have reported instances citing its value in the treatment of bleeding accompanying biliary obstruction

Not long ago, however, venesection was occasionally used for the control of bleeding, based on the fact that hæmorrhage is spontaneously arrested after the acute loss of a large quantity of blood² Von den Velden¹³⁰ had practiced segregating the blood in the extremities for this purpose As recently as 1910, venesection was recommended by Sahli¹⁰⁷ for the treatment of bleeding in hæmophilia

Euphyllin has been found by Nonnenbruch and Szyszyka⁹¹ to decrease the coagulation time on injection Calcium and tissue extract if added to blood in vitro or if injected, appear to decrease the clotting time Witte's³³ peptone has no influence on coagulation when added to blood in vitro but when injected intravenously, inhibits the clotting of

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blood shed subsequently Atropin injected into the portal circulation of the dog has the same effect but does not influence blood clotting when added in vitro Sodium citrate inhibits clotting in vitro but may accelerate coagulation when injected into the organism Wilkie¹¹³ recommends its use in the treatment of bleeding of biliary obstruction

This brief recapitulation of the usual and most effective hæmostatic remedies employed in the treatment of hæmorrhage has been made only to indicate that an increase in coagulability and a reduction in the clotting time of blood may be effected by a large number of means A shortening of the time in which blood clots following the successful employment of a certain agent in the arrest of hæmorrhage does not necessarily indicate a deficiency in the organism of the remedy used Decrease in the clotting time of the shed blood of patients with obstructive jaundice following the intravenous injection of calcium chloride does not signify a functional deficiency of calcium It only means that calcium is a good remedy to reduce the prolonged extravascular clotting time of the blood in biliary obstruction

5 *The Relation Between Delayed Coagulation and the Tendency to Bleed*—A point that requires emphasis in the discussion of hæmorrhage in jaundice is that the entire problem does not hinge on a decreased coagulability of the blood Mere delay in the extravascular clotting is not responsible for the spontaneous hæmorrhages that may obtain in icteric patients Nor can prolonged bleeding from the operative wound in patients with biliary obstruction be attributed solely to delayed coagulation of blood The problem of the arrest of hæmorrhage in vivo is not as simple as the solution of the process of clotting in vitro

In the normal circulating blood prothrombin (thrombogen), calcium, and fibrinogen are all present The circulating blood remains fluid because thrombokinase is present in no great amount, or because an excess of antithrombin is not present

In the arrest of hæmorrhage following operative incision on a patient in whom no hæmorrhagic dyscrasia is present, an adequate hæmostasis is obtained by the ligation of the large vessels (arteries and veins) Spontaneous arrest of bleeding ordinarily occurs in the smaller vessels (capillaries, arteries, and venules) Following the exhibition of heat or pressure, or the local application of an astringent the hæmostasis in the lesser vessels can be accelerated The failure of this spontaneous arrest of hæmorrhage to occur in the smaller vessels in a hæmorrhagic diathesis indicates the inadequate formation of blood platelet thrombi to occlude the vessel, or an inability of the vessel to retract properly After division the intima of the normal vessel rolls in like the end of a glass tube exposed in a flame Even the capillaries without muscle tissue in their walls possess an inherent power of contracting when injured¹²¹ Undoubtedly, this contraction of the smaller vessels is of primary importance in the control of bleeding Stegemann¹²⁰ says that in the finer vessels thrombus formation does not occur and that the contraction of the vessel alone causes internal apposition and arrests bleeding

In patients with purpura hæmorrhagica, an improper blood platelet thrombus formation due to the deficiency of blood platelets accounts for the tendency to bleed. A deficiency of calcium in the circulating blood has not been adequately demonstrated in any hæmorrhagic disease. In hæmophilia, no quantitative diminution of the blood platelets is present. It has been suggested that the etiological factors concerned are a qualitative change in the blood platelets and a deficiency of prothrombin⁸⁴. In both hæmophilia and the bleeding of obstructive jaundice, a prolonged extravascular coagulation time of the blood and a tendency to bleed after trauma are present. In the hæmorrhagic dyscrasia of biliary obstruction a deficient contraction of the smaller vessels and an inadequate blood platelet thrombus formation would appear to be as much responsible for the bleeding in these patients as is the delay in the extravascular clotting of the blood. The dyscrasia does not reside in the blood alone, the blood-vessels must also be implicated.

Morawitz⁸⁶ has stressed the importance of determining the bleeding time described by Duke,⁴³ in hæmorrhagic conditions. He believes that its determination is much more important than that of the clotting time. He points out that the bleeding time may be prolonged when the coagulation time is normal (Purpura) but knows of no condition in which the bleeding time is normal when the coagulation of the blood is prolonged. In his hands hæmophilia, jaundice (with a prolonged clotting time), phosphorus poisoning, and experimental hindlimb injection always exhibit a prolonged bleeding time.

It would seem that in a disease in which there is a decided tendency to bleed after operative trauma as in jaundice (with prolonged coagulation) or hæmophilia that the bleeding time should also be prolonged. If the bleeding time does not determine the tendency to bleed after trauma what does it determine?

It is true that most investigators obtain a normal bleeding time in the hæmorrhagic diathesis of biliary obstruction. The bleeding time in the four patients reported here were consistently normal. In purpura hæmorrhagica, when purpura is present, the bleeding time is always prolonged. Is it that the bleeding time as it is ordinarily determined, measures only an inadequate blood platelet formation and that the plunging of a needle to a depth of about 4 mm into tissue does not test the contractibility of the vessels?

Treatment—The hæmorrhagic dyscrasia of obstructive jaundice is due to liver injury and diminution of liver function. Briefly stated, the treatment most urgently indicated to avoid hæmorrhage lies in the early relief of biliary obstruction.

At the present time, the best index that we have of the tendency of jaundiced patients to bleed is the coagulation time of the blood. The tendency to bleed and delay in the extravascular clotting of blood, however, do not always run parallel. That post-operative bleeding may obtain despite reduction of the coagulation time is well known. An unoperated patient referred to in this report died suddenly from extensive hæmorrhage into the entire intestinal tract when the clotting time determined on the same day was normal.

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That the tendency to hæmorrhage and delay in the clotting of blood in patients with biliary obstruction may remain refractory to all methods of treatment is illustrated in the histories of two of the patients related here. When both delay in coagulation and the tendency to spontaneous bleeding are present, conservative means of treatment are less effective than when delay in clotting alone is the only stigma of an abnormal hæmostasis. Elsewhere,¹³⁸ the writer has reported the instance of a patient with profound jaundice of three and one-half years' duration, in which no tendency to spontaneous hæmorrhage had been manifested. A clotting time of fifty minutes was reduced to an almost normal reading after calcium administration and transfusions. No bile-ducts could be demonstrated at operation and the patient died five days later. No tendency to bleed was manifested, nor were any hæmorrhages found at the postmortem examination.

At the University Hospital, calcium chloride has been given pre-operatively to all patients with obstructive jaundice as outlined by Walters, for several years. When the clotting of the venous blood of jaundiced patients is delayed we have found the intravenous injection of calcium chloride to be more effective in the reduction of the delayed coagulation than other remedies. But when hæmorrhages occur post-operatively we have cause to rely more on the transfusion of unmodified blood by the Kimpton-Brown tube method than on other measures. Anything that improves liver function may have a favorable influence on the tendency to bleed. W. J. Mayo⁸¹ has emphasized the value of the administration of glucose to patients with hepatic insufficiency. After hepatectomy in dogs, Mann and his associates⁸⁰ have been able to prolong the period of survival for several hours following the intravenous injection of glucose. The value of hypertonic solution of glucose as a hemostatic agent has already been referred to.

What is to be done with the patient whose delay in coagulation remains refractory to all the conservative means of treatment? It is stated that to operate in the presence of a persistently delayed coagulation is only to invite disaster.^{67, 111} In hæmophilia, patients have a recurring cycle in which the tendency to bleed after trauma is increased. In some phases of the cycle, the coagulation time may be normal, and the patient may manifest little or no tendency to bleed. In obstructive jaundice, in which the factor of biliary obstruction continues to operate, it is not likely in the presence of complete obstruction that the hæmorrhagic diathesis may become automatically adjusted, as McVicar and Fitts⁷⁶ have suggested. Postponement of the relief of biliary obstruction after transfusion and calcium have failed to bring about a normal blood coagulation, only permits the vicious cycle to become worse. When it can be demonstrated that the obstruction is incomplete, delay may have some virtue. But to continue with conservative measures, when a fair trial has been of no avail in the reduction of delayed clotting, is procrastination that increases the liability to hæmorrhage when operation is performed.

Those who withhold from operating on patients with complete biliary obstruction with a persistent delay in the coagulation of the blood point to the

enormous mortality of operating for the relief of obstructive jaundice due to malignancy. Without operation, however, the outcome is not long delayed and the mortality is always 100 per cent.

In one of the instances reported here operation was withheld because of the ascites, the delayed coagulation of the blood and spontaneous tendency to hæmorrhage. The operative risk in such a patient, of course, would have been great (75 per cent in the light of compiled statistics^{58b}) but the post-mortem findings certainly indicated that an operative attempt would have been worth while. A small localized carcinoma of the bile-duct was found at the point of union of cystic and hepatic ducts. The ascites was due to biliary obstruction. No metastases were demonstrated.

It is known that a patient may first exhibit the tendency to hæmorrhage after the drainage of bile has been established. One such instance is reported here but fortunately the outcome was favorable after repeated transfusions. Petren⁹⁸ reports fatal instances that bled only after drainage had been effected for several days. Such an occurrence suggests that the sudden release of the biliary obstruction may temporarily increase liver damage, diminish liver function, through œdema or other cause, and increase the liability to hæmorrhage. The danger of sudden decompression of the distended urinary bladder following chronic retention of urine is, of course, well known. Crile¹² and Reid¹⁰¹ have already suggested for other reasons gradual decompression of biliary obstruction in chronic icterus. Reid believes that a "serious toxic state" may occasionally occur after the sudden decompression of the common bile-duct of deeply jaundiced patients.

That the important factor in the avoidance of hæmorrhage in patients with biliary obstruction lies in the early relief of the obstruction cannot receive too much emphasis. The greater number of patients needing surgery for the relief of obstructive jaundice come to operation when the block in the bile flow has been present for many weeks and even months. Rovsing¹⁰⁴ stated that in unremitting obstructive jaundice of two to three weeks' duration the patient should be submitted to operation at once. Schmieden and Sebening¹¹³ believe that when biliary obstruction has been complete for more than two weeks and delay in coagulation is present that conservative means are of no value in its treatment. Kehr⁶¹ stated that when biliary obstruction has been present for more than five or six weeks, operation, because of the danger of hæmorrhage, carries an extremely high and unnecessary risk.

When catarrhal jaundice, which occasionally occurs even at the time of life when operations for the relief of biliary obstruction are common, can be ruled out by a short period of observation certainly operation should not be deferred, in the presence of increasing jaundice.

In a patient in whom the jaundice is due to cholangitis, a simple decompression operation as advised by Crile¹² would appear to be the operation of choice. When the obstruction is due to a stone in the common bile-duct and can readily be removed, this should be done, but the removal of the gall-bladder even though stone-containing or diseased should be deferred to a later date. Unnecessary operating is to be avoided.

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In patients in whom a carcinoma of the pancreas is found (or a chronic pancreatitis causing jaundice, a rare occurrence) a cholecysto-duodenostomy is to be performed. When a carcinoma of the bile-ducts is present and excision of the tumor feasible a hepatico-duodenostomy or an anastomosis employing the gall-bladder should be done. A simple drainage operation (cholecystostomy) in the cases of duct malignancy carries the same mortality as an anastomosis operation and these patients stand a complete external biliary fistula poorly.

The choice of a suitable anæsthetic agent in the presence of chronic icterus is very important. The avoidance of chloroform needs no emphasis. The occasional occurrence of anuria after operation on jaundiced patients under ether has prejudiced the writer against its use. It is known, of course, that anuria may obtain in the course of obstructive jaundice in unoperated patients and it may be that the operation itself is as much responsible for the complication of anuria as is the anæsthesia. But when possible, the operation should be done without ether. The preliminary injection of morphine combined with novocaine anæsthesia of the abdominal wall and the administration of nitrous-oxide anæsthesia usually gives sufficient relaxation. An adequate incision gives good exposure and expedites the surgical procedure.

SUMMARY AND CONCLUSIONS

The histories of two unoperated patients who died with spontaneous hæmorrhages due to biliary obstruction are reviewed. The instance of another patient is recorded in which fatal bleeding followed the excision of a stricture and reconstruction of the common bile-duct. Another instance is reported in which the patient almost lost his life through the agency of parenchymatous hæmorrhage when no dyscrasia of coagulation could be demonstrated preoperatively.

It is pointed out that the retention of bile in the organism *per se* is probably not responsible for the hæmorrhage diathesis of obstructive jaundice. The destruction of liver tissue and the diminution of liver function, consequent upon the biliary obstruction, would appear to be the chief etiologic factors.

The tendency to bleed exhibited by patients with obstructive jaundice does not depend on delay in the extravascular clotting of the blood alone. The blood-vessels as well as the blood itself in this respect are abnormal.

The important principle in the avoidance of hæmorrhage lies in the early relief of biliary obstruction. In the reduction of delayed coagulability the intravenous injection of calcium chloride is the most dependable agent. In the treatment of parenchymatous hæmorrhage, after operation, the transfusion of unmodified blood is of most value. In instances of unremitting jaundice in which the delayed clotting remains refractory to all the conservative methods of reduction in the absence of other contraindications, biliary decompression should be done at once.

Hæmorrhage following operation for the relief of biliary obstruction is still an important cause of operative mortality.

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BENIGN TUMORS OF THE STOMACH *

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BENIGN tumors of the stomach are not common. In four thousand roentgenological and clinical examinations of the stomach in our clinic since 1920 only three have been found. Besides the benign tumors one gastric hair-ball was encountered. On account of the relative infrequency of benign lesions we have considered it of sufficient interest to report and discuss each case emphasizing a few points in diagnosis and surgical technic.

These cases have taught us that one must continually bear in mind that a benign gastric tumor although rare, may be the cause of an atypical gastrointestinal complaint or an unexplained chronic anemia. Eusterman has shown that less than one-half of one per cent of gastric neoplasms are benign. Balfour and Henderson report a series of fifty-eight cases of benign tumors of the stomach encountered at operation. Braun and Pearl report five proven and seven probable cases of diffuse gastric polyposis.

Benign tumors of the stomach are briefly classified as papillomata, myomata, adenomata, fibromata, lipomata, osteomata, cysts and adeno-papillomata, the latter commonly called polyposis.

CASE I—Seen in consultation with Dr W A Taylor, Ellensburg, Washington, November, 1920. Mrs H A, age thirty-five, consulted Doctor Taylor in August, 1920, on account of severe gastric hemorrhage. The patient was hospitalized for ten days during which time two transfusions were given. Rontgenologic examination of the stomach and duodenum was said to be negative. Gastric acidity was slightly above normal.

Ten days after leaving the hospital another gastric hemorrhage occurred. She returned to the hospital and sixteen transfusions were given, endeavoring to get her in condition for operation. During this stay in the hospital a smooth tumor could be palpated in the upper left abdomen. At operation Doctor Taylor found a pedunculated tumor about the size of a grape fruit attached by a small pedicle to the posterior wall of the stomach.

Microscopic study of the tumor was made by two pathologists and both reported "spindle-celled sarcoma." The patient, however, has been free from gastric symptoms since the operation seven years ago, and reconsideration by the pathologists has classified the tumor as a leiomyoma.

CASE II—24747 W W, male, age forty-eight, came to clinic July 25, 1927, complaining of severe diarrhoea.

Clinical History—Well as a boy, graduated from college in 1901, from then until 1909, lived as a bachelor and much of the time did his own cooking. The diarrhoea from which he now seeks relief began in 1902, and since then it has bothered him each year although he states that he does not believe that the severity of the attacks of diarrhoea

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have been as severe since 1910 as they were previous to that time and attributes this to the more careful selection of his diet

In 1903, the patient had an attack of indefinite upper abdominal distress associated with jaundice and fifteen to twenty bowel movements a day. The diarrhoea was not painful, no blood was seen, but he passed considerable mucus. The patient believes that these attacks of diarrhoea are often precipitated by nervousness.

In 1924, the gall-bladder was removed and the patient believes that the bowels have caused him less trouble since then until the past six months. In October, 1924, a rather marked pigmentation appeared on the hand and on account of this glove pigmentation associated with diarrhoea a diagnosis of pellagra was made in California.

In September, 1926, he weighed 175 pounds. In February, 1927, he suffered from influenza and considered himself too busy to allow sufficient time for convalescence. In May he began to have another severe attack of diarrhoea. He was examined clinically and roentgenologically by his family physician who found no trouble in the stomach. He was placed on frequent feedings of eggs, meat, vegetables and orange juice. There was some improvement and he went to a resort to convalesce, and while there his diarrhoea recurred.

On arriving in Seattle last July, his condition was so critical that he immediately went to a hospital.

Rontgenological examination of the stomach showed three small tumors in the posterior upper third of the stomach. The technic used to demonstrate the lesions will be discussed later. Examination of the colon by means of the barium enema was negative. Several stool examinations failed to reveal any definite abnormal findings and proctoscopic examination was considered negative.

On July 30, 1927, the patient was operated on by Doctor Mason. The stomach was opened by a midline incision. Five polyps were seen. Three had been detected by the X-ray, one about the size of a lemon and two about the size of a cherry. The remaining two were about the size of a cherry seed.

Pathological examination of the polyps showed each to be a very vascular mucus polyp covered by a single layer of gastric mucosa. The underlying tissue was mucoid in character, similar to that seen in a nasal polyp, definitely a benign tumor.

Convalescence was remarkably uneventful and there has been no recurrence of the diarrhoea to date.

CASE III—W. J. W., 25675, age sixty-seven.

Personal History—He states that with the exception of a chronic constipation of many years' duration he has always enjoyed good health.

Clinical History—Well until October, 1926, when he lost his taste and appetite which have never returned. At that time he weighed 178 pounds. During the past year he lost sixty pounds in weight and consulted a physician then on account of loss of weight and weakness in his legs. During September, he began to complain of pain in the lower abdomen—"felt like he was full of gas." During September and October, he occasionally felt nauseated and vomited a few times and had two rather severe attacks of diarrhoea.

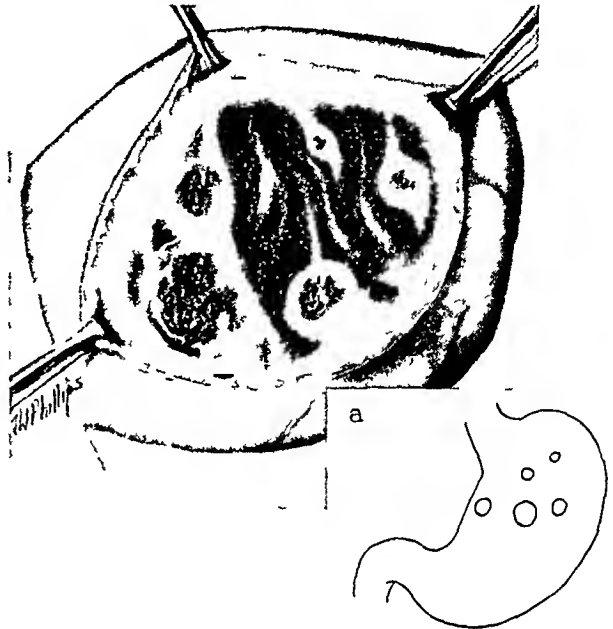


FIG. 1.—Case II. Showing polyposes on the posterior wall of the stomach. a. Showing size and location.

one lasting three days, the other seven. Considerable amount of blood was passed, once during the latter attack of diarrhoea.

During the past year he has been troubled with frequency of urination, often urinating ten times during the night. Urinalysis was negative. Red blood cells, 3,130,000, leucocytes 14,000, hæmoglobin 48 per cent.

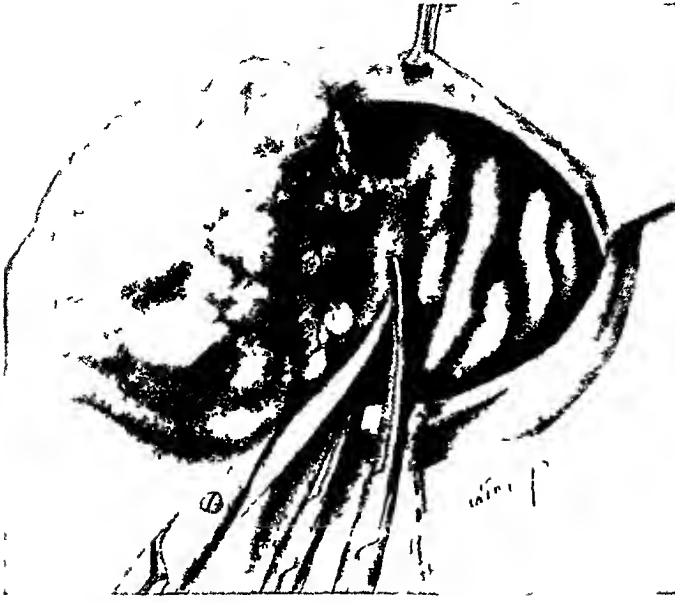


FIG 2—Case III. Large single pedunculated polyp.

Physical Examination—Considerable emaciation. Head, neck and chest negative. Abdominal mass size of an orange palpable in epigastrium. On account of emaciation, the mass at this date was easily felt.

Operative Findings—On opening the stomach a large pedunculated tumor about size of an orange was found attached to the posterior wall. On account of its marked irregularity and cauliflower appearance it was thought to be either an adenoma or a carcinomatous degeneration of the adenoma. Microscopic exami-

nation shows a marked irregularity of the surface but no evidence of carcinoma. The mass itself is definitely a fibro-myoma with marked inflammatory changes.

Operative Technic—The operative technic for benign tumors of the stomach is very simple. In each case a small transverse incision was made in an avascular surface of the stomach. These incisions were enlarged to three times their size by gentle retraction with small retractors. We feel that this is probably one of the most important steps in the operation. One of these patients received gas and ether inhalations, one gas and local anæsthetic, and one local anæsthetic only. The post-operative convalescence was practically the same. In approaching the benign tumors hæmostats were applied to the base being attached well on the side of healthy mucous membrane. The tumors were removed with a long pair of curved scissors and an actual cautery applied to the base above the hæmostat. The cautery was held on the blade of the hæmostat until we felt that that instrument had received enough heat to coagulate the tissues and blood-vessels to the immediate tissues. The grasping area of the hæmostat was then whipped over with a running suture of double dulox. The hæmostat being



FIG 3—Cross section of the tumor.

whipped over with a running suture of double dulox. The hæmostat being

loosened and slipped out of place before the suture was pulled taut. Over this approximation several interrupted wax sutures were placed.

SUMMARY

In reviewing these three cases of benign tumors of the stomach, one is impressed by the lack of any gastric symptoms. All complained of weakness, anemia and loss of weight but none attributed their ill health to a lesion in the stomach. Diarrhœa was very persistent in one case and was practically the sole complaint.

The most important means in the diagnosis of these cases was the roentgenologic examination. All the tumors found in these three cases were located on the posterior wall of the stomach. The method now used to demonstrate lesions located on the posterior wall, is one of the many things to which roentgenologists shall always be grateful to Dr. Russel D. Carman. Carman in 1923 presented a newer method of demonstrating lesions located on the posterior wall, especially those situated in the upper third of the stomach. These cases have taught us to never omit the method from our routine. It was formerly our practice after following the barium mixture through the œsophagus to centre our attention on the duodenum, because the duodenal cap is frequently well visualized after the first few swallows of the liquid. Now observation is made to determine the course of the barium stream as it descends in the stomach. Normally the stream follows a direct course in the upper part of the stomach until it impinges on the gastric wall and then descends as the stomach relaxes before it. If a growth is present high on the posterior gastric wall the barium stream will be deflected to one side or the other or if the mass is comparatively small the stream may be divided. When the stomach is partially filled with the barium suspension, careful palpation approximating the gastric walls will project the fluid about the viscus in a thin layer, and will show a filling defect on the posterior wall which could not be seen otherwise. These growths are not seen if enough media is in the stomach to completely submerge them. During the manipulation of the partially filled stomach attention should be directed to the parallel streaks representing the sulci between the rugæ of the stomach. These rugæ are obliterated in the area of the tumor.

The value of careful palpation of the partially filled stomach during fluoroscopy cannot be emphasized too strongly. It is our opinion that if this is made a routine procedure, we will not have an occasional report of a benign gastric lesion but probably many of them within the next few years.

FASCIAL SUTURES FOR INGUINAL HERNIA *

By HENRY H M LYLE, M D

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THE object of this paper is to give the clinical results obtained in the employment of autoplasic fascial sutures in the treatment of inguinal hernia in the male

We will not go into the pros and cons of the experimental question whether fascia does or does not readily unite with muscle We are simply endeavoring to find out whether we can obtain better clinical results with living fascial sutures than with catgut We wish to emphasize the following facts This is a preliminary report based on a relatively small number of cases Living fascia is apparently a reliable suture material but is only to be considered as an adjunct to sound hernial surgery

We have employed fascial sutures for five and one-half years At first we used the Gallie method exclusively, reserving it for the severe herniæ As we gained more confidence in the fascial suture we made a tentative trial of the McArthur method Two years ago we adopted it for our routine cases, to a limited extent it is used by my associates

Fascial Methods Employed —In this series we reserved the Gallie method of free fascial sutures for the large direct and recurrent herniæ, adhering closely to the technic described by Gallie

In the first forty cases in which McArthur autoplasic pedicle fascial flaps were employed we followed the technic as laid down by McArthur In the remaining cases we employed the mesial fascial strip to unite the conjoined tendon to Poupart's ligament, and omitted the use of the external strip to unite the cut edges of the external oblique We proceeded on the assumption that fascia unites to fascia more readily than to muscle and used chromic gut for this union On several occasions we have been embarrassed for the want of sufficient fascia to cover the cord It was on account of this difficulty that we fell into the error of employing the easier method of bringing the cord external to the external oblique This error we have sincerely regretted With the exception of this modification and the occasional tacking down of the fascial suture with chromic catgut, we have adhered to the technic described by McArthur

Operations Employed —Two types of operations were employed in this series, the standard Bassini repair and the Halstead modification After a fair trial the Halstead modification was abandoned as it violated the essential physiological principle of muscular shutter closure In our hands the Bassini repair has given better clinical results So far all the recurrences in this series, with the exception of one, have been in patients operated on by the Halstead method

* Read before the New York Surgical Society, March 28, 1928

We have not employed the rectus transplant or any of its variants believing that these procedures are physiologically and anatomically unsound

In all operations we strive to carry out the following principles

1 Excision and high ligation of the sac, fixation of the sac well above and out of line with the internal abdominal ring

2 A high closure of the internal ring about the cord paying particular attention to the suturing of the transversalis fascia well up behind the cord

3 In suturing the conjoined tendon to Poupart's ligament, we pass the continuous fascial suture in such a manner that the conjoined tendon is shortened and its insertion into the pubic spine strengthened. With the same suture, the arc of the arched fibres of the internal oblique is sutured low down on the mesial and posterior aspect of the cord. This combined with a high suture of the transversalis fascia lengthens the canal, separates the internal from the external opening, converting the pathological canal into one which more nearly approaches the normal. The defensive muscular mechanism of the reconstructed canal, when tested by voluntary and electrical stimulation, shows a very efficient functional shutter closure

4 Immediately upon the completion of the stage of dissection the patient is placed in the position of physiological relaxation. In this position the gap between Poupart's ligament and the conjoined tendon is obliterated or materially reduced and a low muscular suture can be inserted without tension†

5 In order to insure a permanent union between the structures to be united, it is essential to remove not only the loose gliding areolar tissue from the fascial strips but also to clear Poupart's ligament

6 The needle should be large enough to allow the fascia to be pulled through without dragging. A ligature is tied to the fascial suture and its ends passed through the eye of the needle. It will be found that this method of attaching the suture to the needle is simple, less wasteful and the suturing smoother

After-care—Careful instruction regarding the protection of the wound during coughing, straining, etc., should be given. After the period of convalescence has been passed, massage and systematic exercises to strengthen the abdominal muscles and improve the muscular control of the inguinal region should be insisted on

† To obtain this position the thigh is flexed on the abdomen, and the leg on the operative side is crossed over the opposite one. This relaxes Poupart's ligament which in turn automatically relaxes the internal oblique, transversalis and conjoined tendon. Further relaxation can be obtained by flexing the thorax on the abdomen which relieves the tension on the external oblique, the recti and the conjoined tendon. The patient is returned to the ward in this position, the leg uncrossed and the patient put to bed in the position of relaxation. This position is maintained throughout convalescence. The position of physiological relaxation has been used for eighteen years and is considered as essential in the treatment of hernia as physiological balance and muscular relaxation is in the reduction of fractures

Results —To date the fascial suture has been employed in 335 herniæ, 159 of these have been followed from eighteen months to five and one-half years. The average follow-up report covers two years. The patients have been examined by one or more members of the surgical staff. All patients are males of eighteen years or over, the oldest was sixty-five, the average forty-two and five-tenths years, 75 per cent were laborers. Follow-up reports by letter are excluded. There were 132 McArthurs and twenty-seven Gallies.

In 101 operations for indirect herniæ there were three recurrences—3 per cent.

In fifty-four operations for direct herniæ there were five recurrences—9.5 per cent.

In four operations for direct indirect herniæ there were no recurrences. That is in a total of 159 cases there were eight recurrences 5 per cent. During the same period there were 271 herniæ operations repaired by catgut. In 200 indirect herniæ there were eighteen recurrences (9 per cent), in seventy-one direct herniæ there were ten recurrences 14 per cent. That is with catgut suture there was a recurrence of 10.3 per cent and with fascial sutures 5 per cent. Three important factors are to be kept in mind in comparing these figures. Before the adoption of the fascial suture as a routine we had limited it to the severe herniæ, the fascial suture was a new method requiring experience and a new technic, several operators had to get their experience. In future it is reasonable to expect that we may obtain a higher per cent of cures.

Infections —There were five infections of the hernial wounds in 159 cases 3.1 per cent, and one in the fascia of the thigh. Two of the recurrences can be directly charged to infection, the remaining three cases, which were infected, show no sign of recurrence.

Recurrences —There were eight recurrences in this series, seven of these occurred in the Halstead modification of Bassini operation, the remaining one in the Bassini. Five occurred in direct herniæ, three in indirect. There were no recurrences after the Gallie operation. Two of the cases can be directly charged to infection, a third to a mistake in judgment of employing McArthur in a large sliding hernia when a Gallie should have been used. This case subsequently repaired by the latter method and has held. Of the five remaining patients four have been operated on, three of these had recurrences protruding directly from the internal to the external ring. In these patients the cord had been brought anterior to the external oblique fascia. The musculature was firmly united to Poupart's ligament and the fascial sutures were in place. Microscopical examination showed them to be composed of living fibrous tissue.

Other Data —The oblique hernia represented 62.9 per cent of the cases, the direct 37.1 per cent. There were thirty-eight bilateral herniæ 68 per cent of which were direct, and nineteen recurrent cases. One case had been operated on three times, three cases twice. The high proportion of direct and recurrent cases operated on, is due to the fact that in the early part of this series, these were the only cases in which the fascial suture was employed.

FASCIAL SUTURES FOR INGUINAL HERNIA

SUMMARY

- 1 The fascial suture is still on trial
- 2 The fascial suture lives and unites with muscle
- 3 In this series the fascial suture has given much better results than catgut
- 4 The Gallie method is indicated in the difficult herniæ and by its use the field of operability can be widened to include cases which we formerly believed inoperable
- 5 The future progress in hernial surgery will be along physiological lines, and the problem will solve itself when we can establish as an efficient muscular mechanism as the one which guards the normal inguinal canal

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FURTHER EXPERIENCES WITH PURELY FASCIAL HERNIOTOMY

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IN AUGUST, 1924, I described in this Journal a technic for closing inguinal hernias, utilizing only white fascia¹. Since that time I have used an identical or similar technic in all my cases and am more firmly convinced of the value of the principle. While the experimental work of Koontz² and Rosenblatt and Cooksey³ have not entirely agreed with the reports of Seelig⁴ on the possibility of muscle fascia union, it is nevertheless obvious that this can never be as firm as fascia-to-fascia stitching. This principle is so well recognized in abdominal surgery as a whole that practically the entire strain is supposed to be taken up by the connective tissue layers, and few if any muscular stitches are inserted in closing most laparotomies.

In doing about three hundred and fifty herniotomies, the most important lesson I have learned is that no one type of operation can or should be applied in all cases. Every hernia is a problem of its own, and the surgeon should open the inguinal canal prepared to undertake that plastic procedure which will best fit the case. I feel strongly that a great deal of our failures in herniotomy have been due to too much surgery rather than to too little surgery. It is a very striking thing that in every series of recurrences, recurrence takes place in the majority of cases at the pubic end of the canal and not at the internal ring where the hernia was in the first place. It is only fair to ask by what right we call these recurrences. There was no hernia in this position before, and I believe that we are actually causing hernias to appear in the lower end of the canal by too much stitching of layers which are intact, and have up to date prevented any herniation at that point.

For these reasons I have been doing an increasingly high percentage of cases by the simple removal of the sac, sometimes with a stitch or two in the endo-abdominal fascia to tighten up the internal ring, and closing the canal without any more surgery. This operation, to my mind, is sufficient in most hernias in young children and in a moderate percentage of recently acquired hernias in adults. In such cases the peritoneally lined sac is the only real pathology. The canal is intact. The muscular and aponeurotic structures have not been stretched or torn by prolonged tension of a hernia and the internal ring is little if any enlarged. If one is careful to dissect the neck of the sac very high into the abdomen, a mere transfixion and ligature will often include the edges of the internal ring, and the closure of this hole is

FASCIAL HERNIOTOMY

quite sufficient guarantee against recurrence of a hernia of this type. In such cases I believe that attempts to close the lower end of the canal by dragging fascial or muscular structures down to Poupart's ligament under extreme tension often is worse than futile. There is no hernia in this region at the time of the operation, but statistics show that operation is frequently followed by hernia in the lower end of the canal. It seems a perfectly justifiable conclusion that these hernias are caused by cutting through of stitches which are placed in a misguided attempt to approximate the structures which do not belong together. The stitches therefore cut through and leave holes in the floor of the canal through which the so-called recurrent hernias emerge. About 30 per cent of my cases have been treated by some such method as this (Sac removal alone).

It is a disgrace to surgery that this type of herniotomy cannot be done in 100 per cent of cases. I am very sure that if every patient was operated upon immediately after the onset of his hernia that this would be applicable always, and that our recurrence rate would be practically nil.

Unfortunately, however, hernia sufferers are allowed to fool about with trusses for so long before they come to the surgeon that serious injury to the abdominal wall has been produced. Why such a serious lesion as the protrusion of the intestines under the skin should, in the majority of cases, be treated by drug store clerks or mail order houses is very difficult to understand. The entire modern conception of a hernia with the invariable etiology of a performed sac is surely a cogent argument for early operation. Nevertheless, both medical and lay public health organizations seem to be completely oblivious to the necessity of getting hernias operated on before the structures of the lower abdominal wall have been irreparably destroyed. It should be the duty of all medical men to present the facts to the sufferer of hernia in the following light: that he has to choose between operation and truss management. If operation is ever contemplated, it should be done at once and not after a number of months of trauma by both the truss and the hernia to important muscular and aponeurotic structures. In the first few months the cure of hernia is easy and after many years it is far from easy, as can be easily proven by a study of the recurrence rates.

In old hernias we find the following marked changes about the canal:

1. A very constant finding is the atrophy of the lower fibres of the conjoined tendon so that it lies a long way from Poupart's ligament. It no longer inserts onto the pubic bone, but inserts onto the rectus sheath so that a wide triangular hole is left.

2. The endo-abdominal fascia is stretched and thin, as it is the only structure lying between the peritoneum and the external oblique aponeurosis.

Therefore the problem that confronts the surgeon is not simply the removal of a small sac but the removal of a large sac, involving considerable trauma to the cord and the closure of a large defect in the abdominal wall. In such cases the ideal procedure would be to bring the conjoined tendon down to Poupart's ligament below the cord as described by Bassini. Unfor-

unately, however, in only about 30 per cent of cases is this possible. In the remaining 60 or 70 per cent the white fibres in the conjoined tendon have disappeared and the canal is lined by soft, flabby red muscle in its upper border. This muscle may lie as much as two inches from Poupart's ligament when the canal is opened, and virtually always over an inch, and can only be approximated to Poupart's ligament to build a floor of the canal by the application of extreme tension. In the minority of cases in which the conjoined tendon is intact it is so far away from Poupart's that it can be brought down by very tight stitching. For this reason I have abandoned the use of the conjoined tendon suture in about 90 per cent of cases, and prefer to use the almost equally strong and much more movable endo-abdominal fascia. This fascia in hernia sufferers is as a rule very lax and very thin in the floor of the inguinal canal, and for that reason has been much neglected as a material to help our closure. However, if the conjoined tendon and internal oblique are bluntly dissected loose from their attachment and raised with retractors, one can pull down into the canal this endo-abdominal fascia from higher up. It is very elastic and can be drawn down like a shutter for one or two inches without the slightest tension. It has no muscular attachment and therefore does not tend to move with respiration and bodily movements. If this structure is brought down and sutured to Poupart's ligament for the entire length of the canal, we have built a floor for the inguinal region which should preclude any possibility of recurrence. After this has been done I make it a rule to put in one final interrupted stitch in the internal ring so that it will barely admit the tip of the little finger.

Further surgery is a problem of choice. In about half of the cases the gap in the fascia is so large that I reinforce it with the upper fragment of the external oblique aponeurosis exactly as described in the *ANNALS OF SURGERY* four years ago. In about half the cases, however, the floor of the canal appears so strong after the suture of the fascia alone that I have entirely omitted the Andrews' imbrication principle and simply closed the external oblique with a running stitch.

The immediate results of this type of surgery have been very gratifying. The most striking point is the marked lessening of pain in contrast to that of the Bassini or Andrews operation. The fascial layers are practically insensitive, but when one sews the fleshy muscles the stitches are bound to include a number of small nerve fibres, and anatomical studies show us very clearly that the lower border of the internal oblique muscles are very liable to contain large branches of iliohypogastric nerves. These will, of course, be entirely avoided by the technic described. On account of the relative insensibility of the parts sutured there has been correspondingly a very strikingly low incidence of the usual post-operative complications of hernia. Abdominal distention and retention of urine are practically no longer seen in our clinics since we have abandoned the suture of muscles and tendons under great tension.

Unfortunately I am not in position to present any large array of follow-up

FASCIAL HERNIOTOMY

statistics, the only real method of judging the value of any operation. In place of this, however, I have succeeded in getting reports or examinations on forty-three cases of unusually difficult hernias in which it is well known that the recurrence rate is very high. These include

Four hernia permagnæ (all with swelling as large as a child's head)

One epileptic with convulsions almost daily (Operated on account of repeated strangulations)

Two large sliding hernias, both of the cæcum

Two strangulated hernias in which extensive drainage of frankly infected wounds was needed

Two hernias in old asthmatics (Operated because of repeated strangulations)

Three large recurrent hernias (Two operated twice before)

One incarcerated hernia in a three-months' pregnant woman (Later went to term)

Twenty-nine direct hernias

In the direct hernias it is the consensus of opinion that the recurrence rate is about 25 per cent, and they were the most favorable of the collection

The average age of the series was fifty-eight

Six had albumen in the urine, two were mild diabetics, one had a myocardial disease of great severity, and was operated upon because of repeated attacks of strangulation which threatened his life

Ten were operated under local and forty-three under general anaesthesia

Of those here tabulated thirty-five were examined by me and nine were reported on from examinations by other physicians

Of this collection of difficult cases there were but four recurrences in a period averaging from ten months to four years. The average post-operative time was one year and ten months

The failures may be tabulated as follows

One developed extensive ascites within four months (the myocardial case) and had a large double recurrence

One asthmatic recurred on one side after six months

One had an extensive double recurrence after an uncomplicated direct hernia operation

One remained well for three months and was brought into the hospital unconscious, after a taxicab accident. It was his third recurrence. I had examined him three days before his accident and found him normal

This recurrence rate (9.3 per cent) I believe shows a distinct superiority for this fascial type of operation

I do not believe that any particular technic is of as much importance as the principle of closing the internal ring at its highest possible point by the use of fascial stitches. In no other laparotomy would one dream of omitting this stage of the operation, and this is just exactly what is omitted in many methods of herniotomy. The experiences of LaRoque,⁵ Seelig,⁶ Pitzman,⁷ Connell,⁸ and many others have borne out this fact

Carrying this principle to its logical conclusion, McArthur's autoplasic suture, recently revived by Gallie, would seem ideal. The only drawback to this method is this difficulty. In my hands, at least, I have generally had to take about twice as long using autoplasic sutures. The pioneer work of Henry Marc, I believe, showed without a doubt that kangaroo acts almost like fascial graft. A recent article of Koontz⁹ also suggests that dead fascia will work practically as well as live fascia, and for these reasons I have continued to use kangaroo tendon in the closure of these cases.

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THE INTERNAL FIXATION OF FRACTURES AND DISLOCATIONS BY USE OF THE HUMAN FASCIAL SUTURE

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DURING the open reduction of certain types of bone and joint injuries some form of internal fixation is often necessary. For this purpose various materials have been used and various methods¹ have been devised—such

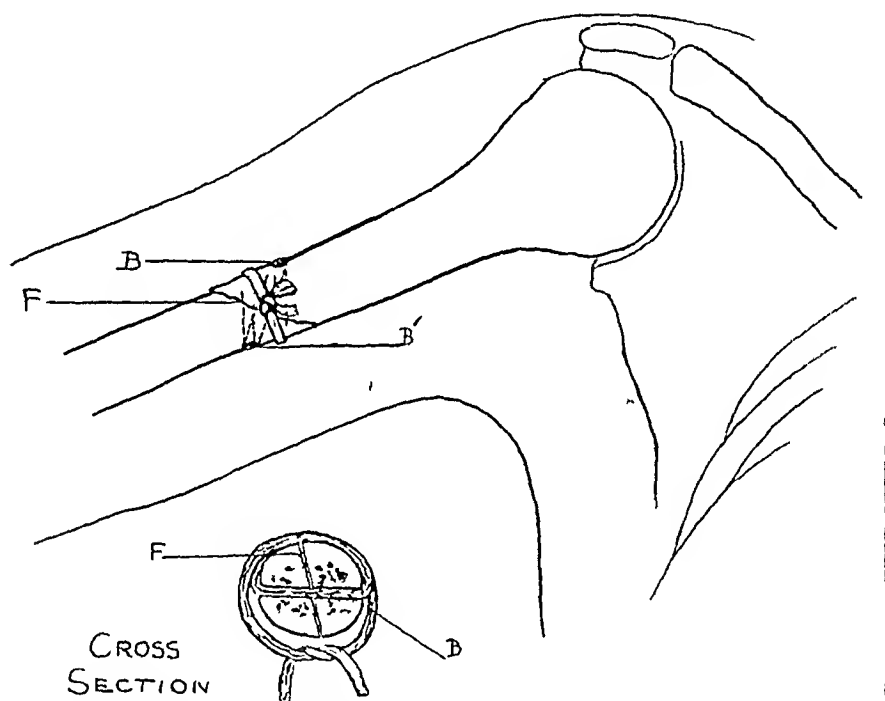


FIG. 1.—Non union of right humerus. Fractured ends approximated. Fascial suture passed through drill holes at points B—B'—the suture being crossed behind and tied in front. The insert shows a cross section of the suture B through the drill holes at the site of the fracture F.

as the bone plate, the bone graft, wire, steel nails, bone peg, ivory peg, screws and various other methods, including the use of kangaroo tendon and chromic catgut.

Some of these methods are adaptable to individual cases, but it is generally agreed that where the strain is at all considerable, kangaroo tendon and chromic catgut soften and break, foreign materials of metal, having done their duty, should be removed by a second operation, the bone graft adds time to the operation and often breaks or fails to function properly.

Because the fascial suture has shown such strength when used in other parts of the body, in particular about the knee-joint² and the abdominal wall,³ we decided to use this suture as a method of internal fixation in certain bone

and joint cases to which we thought it applicable. This has undoubtedly been done before in isolated cases, but we have seen no group of such cases reported. We have done fourteen cases thus far and in all excellent results have been obtained. In each case at least one other method of treatment had

been tried and found unsatisfactory. We will not present any argument as to whether or not open operation and internal fixation were the only things to do in these cases. All we wish to show is that the fascial suture was used in each case and it seemed to exactly accomplish its purpose, namely—hold the bones, along with external bandages, until union began to take place.

The end result of the fascial suture itself is naturally an interesting point. There is much in the literature about the transplantation of fascia to soft parts,⁴ and about the functioning of fascia when used about joints, but we have not come across data on actual cases or on animals regarding the final change fascia undergoes when transplanted and sutured through the ends of a fractured bone. This we hope to do experimentally and report at a later date.

There has been some serous exudate at the site of the operative wound in four of the fourteen cases. Whether this is due to slight infection or the poor vitality of fascia sutured in bone, we do not know, but the wounds all healed well finally, and the delay in healing has in no case been serious.

The drawings are from actual cases. They are diagrammatic. It was thought that these drawings would be more illuminating than the X-ray prints. We have

used this method on the Cornell Division at Bellevue Hospital, and the Third Surgical Division at the Hospital for Ruptured and Crippled.

A description of five cases illustrating the method follows.

CASE I—(Fig. 1)—Patient, C. G., age twenty years. An un-united fracture of the right humerus, junction of middle and upper thirds. This was the result of an old compound fracture, the injury occurring on Thanksgiving Day, 1925. At the time of

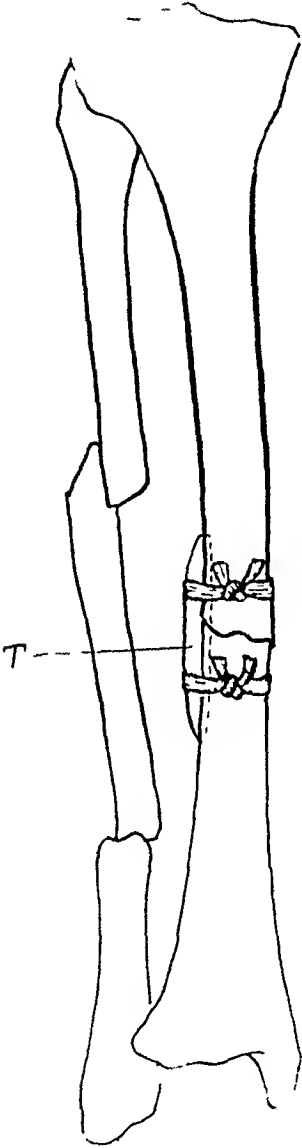


FIG. 2.—Fracture of both bones of the right leg with a large fragment of loose bone (T). Fracture of tibia reduced. Fascial sutures applied so as to hold third fragment (T), acting somewhat as a bone graft.

FASCIAL SUTURES FOR FRACTURES AND DISLOCATIONS

operation the skin and soft parts had been healed for eight months. The operation was performed February 1, 1927, at the Hospital for Ruptured and Crippled. There was an enormous amount of scar tissue and soft part deformity at the site of the fracture. The scar tissue was excised. The ends of the fragments were sawn off obliquely so that when the pectoralis major muscle contracted the upper fragment pulled against the oblique surface of the lower fragment. With a one-quarter inch drill a hole was made

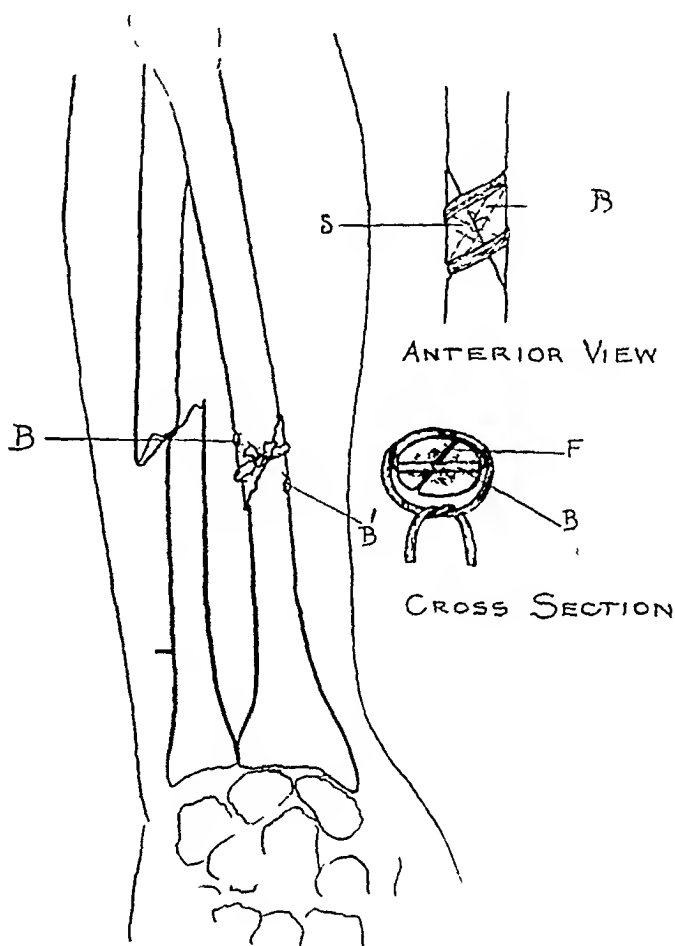


FIG 3—Fracture of both bones of the right forearm. Fracture approximated. Suture B—B' passed through drill holes, crossed on one side of the bone, brought around and tied on the other side. Inserts show anterior of the sutured fracture and also a cross section of same, S indicating the suture passed through drill hole B, F the fracture line.

was finally removed on the twenty-first day post-operative as a fascial slough. The wound finally healed and solid bony union was obtained. Patient is now using the arm as an instructor in carpentry.

CASE II*—(Fig 2)—Patient O P, age thirty-five. Re-admitted to Bellevue Hospital, April 23, 1927. The patient was in an accident, April 10, 1927, at which time he received two fractures of the left fibula, a chip fracture of the internal malleolus and an oblique fracture with a three-inch splintered fragment at the junction of the middle and lower thirds of the left tibia. There was so much swelling and ecchymosis that satisfactory reduction was not obtained. It was thought advisable to do an open operation. This was done April 30, 1927. A long curved incision was made over the flat surface of the left tibia. There was found an oblique fracture. The distal fragment

* This case was presented at the Surgical Section of the New York Academy of Medicine, May 4, 1928.

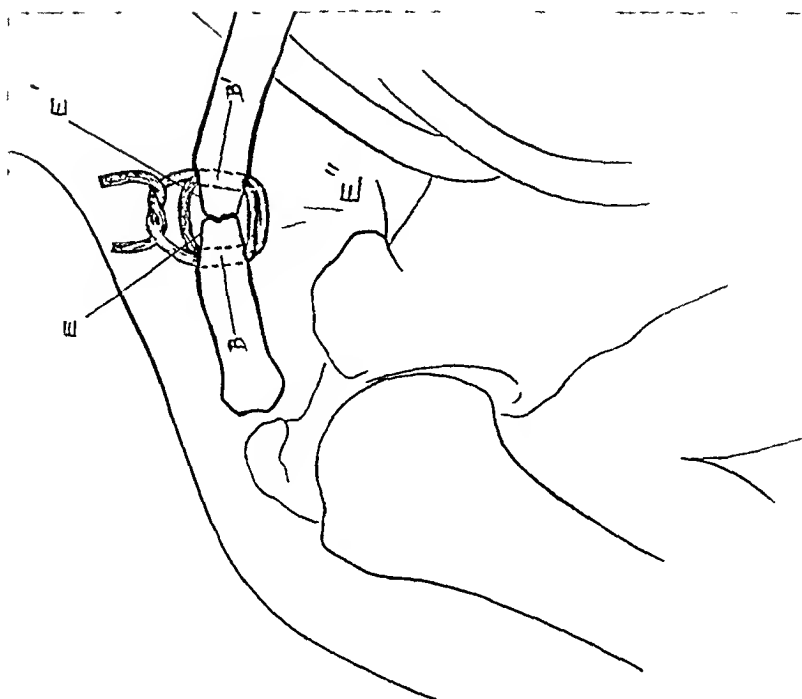


FIG 5.—Fractured right clavicle L—E' and L'' indicating portion of fractured ends shirved down so as to form a bed for the suture, passed through drill holes B—B'. Fracture ends approximated

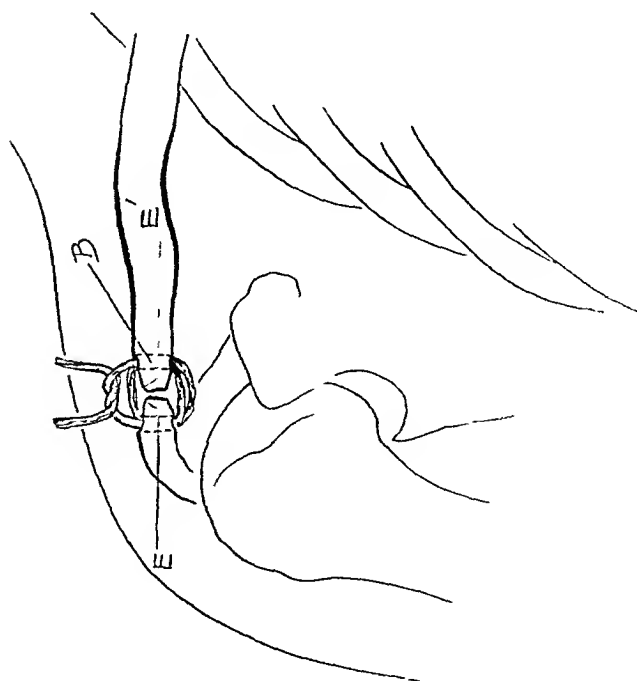


FIG 4.—Dislocation of outer end of clavicle E—E' ends of bone shirved down so as to prevent lateral suture forming a lump on the shoulder B drill holes through ends of bones Dislocation reduced Lateral suture passed through drill holes B

FASCIAL SUTURES FOR FRACTURES AND DISLOCATIONS

was displaced laterally. There was a third fragment three inches long very lightly held by callus and very easy to deliver from the wound. The fragments were separated with a chisel and put in proper alignment. The third fragment was laid along the lateral side of the fracture, from whence it had been displaced, so that it bridged across like a bone graft. Two long strips of fascia lata three-eighths inch wide were removed from the right thigh and were tied around the ends of the third fragment on either side of the main fracture line. Chromic catgut sutures were used to secure the fascial knots. The periosteum was closed with plain catgut, the skin with silk, and a long circular plaster bandage was applied from above the knee including the foot. The wound healed by primary union. Post-operative X-rays showed excellent alignment of the fragments. Patient was discharged from the hospital with a light plaster bandage on the thirty-third day post-operative. Bony union was rapid. Patient was back at his work fourteen weeks after operation.

CASE III—(Fig 3)—H F, female, age fifty-eight. Admitted to Bellevue Hospital, February 24, 1927. Four weeks prior to admission patient had fallen with the right forearm extended, receiving a fracture of both bones of the right forearm. Satisfactory treatment had not been possible because patient had been in a psychopathic ward. Examination showed her to have a fracture of both bones of the right forearm, middle third. There was ulnar and palmar displacement of the distal fragments. There was three-quarters inch shortening and no union was present. Operation performed February 28, 1927. Incision four inches long was made over the lateral aspect of the right forearm. The fractured ends of the radius were exposed, freshened and approximated. A one-quarter inch drill hole was made obliquely through the ends of the fractured bone. A strip of fascia lata one-quarter inch wide was taken from the left thigh and passed through the drill holes, crossed on one side of the fractured ends, brought around and tied on the other side, and the knot secured with chromic catgut. The ulna was not disturbed. The wound was closed in layers in the usual manner. The arm was put in a plaster-of-Paris bandage with the elbow in flexion and the hand supinated. The wound healed by primary union. April 23, 1927, there was solid bony union present in the radius. Passive motion of all joints was fair. On this date physical therapy was recommended and all splints discontinued.

CASE IV—(Fig 4)—J K, age forty-three. Admitted to Bellevue Hospital, May 13, 1927. He had been injured in a taxicab accident. Examination showed him to have a dislocation of the left clavicle with a separation of the acromio-clavicular joint of about two inches. Patient was operated, May 16, 1927, under gas and oxygen anaesthesia. Transverse curved incision was made over the acromio-clavicular joint. The ends of the acromial process and the clavicle were exposed and a one-quarter inch drill hole put through each end. The ends were shaved down with a sharp chisel so that when the suture was tied too much of a lump would not be formed on the shoulder. A long strip of fascia lata was excised from the right thigh. The fascial suture was run through these drill holes and one end carried through the second time and a knot tied on top. The knot was secured with fine chromic catgut. The wound was closed in layers and with ordinary muslin bandage and adhesive the right arm was flexed at the elbow and put up in a modified Velpeau bandage. Primary union was obtained. All bandages were removed in three weeks. A stable, useful shoulder, with normal function, was obtained and X-rays of the joint showed normal anatomical relationship.

CASE V—(Fig 5)—F M, age forty-eight. Admitted to the Hospital for Ruptured and Crippled July 7, 1927, having received an injury to his left shoulder July 1, 1927. Examination showed him to have a fracture of the left clavicle at the junction of the outer and middle thirds. The proximal end of the distal fragment was displaced downward and backward. Better position was sought with the patient under anaesthesia and the application of a plaster spica to his shoulder. This procedure did not improve the position. Accordingly on March 12, which was eleven days after the injury, an open reduction was done. A curved transverse incision with the convexity of the curve out-

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ward, was made over the acromial end of the left clavicle. The fracture ends were delivered and prepared as in Case IV. One-quarter inch drill holes were bored through the clavicle on either side of the fracture. A piece of fascia lata several inches long was run through the second time and the fascia tied securely, the knot being fixed with chromic catgut. The fascial strip used was a leftover from a hernia operation of some ten days previous. The fascia had been kept in Scott's solution. The wound was closed in layers and with muslin bandage and adhesive a shoulder spica was put on the patient. The wound healed with a slight drainage of serum for several weeks. Perfect anatomical position and solid bony union were obtained as well as good function in the shoulder.

CONCLUSIONS

1 The fascial suture is recommended as a method of internal fixation in certain bone and joint injuries.

2 Fourteen consecutive cases have given excellent results. Five of the cases are reported in detail.

3 The suture held for two or more weeks in one case which became infected.

4 Case II would suggest that the fascial suture might be of great use in holding a bone graft in place.

5 Dead sutures or "leftovers" from hernia operations may be used, and in one case did the same work as if autogenous.

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AINHUM

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AINHUM or "Dactylolysis Spontanæ" is of African derivation meaning "to saw or to cut", and is given to a curious disease affecting colored races—more particularly the black. It is characterized by a slow amputation of one or more digits—generally a symmetric separation of the little toes, although other toes or even fingers may be affected.¹

The disease was first reported by G. Messum in 1821.² It was first described by J. F. Da Silva Lima of Bahia in 1852, and fifty cases reported thoroughly described by Da Silva Lima and Wuncherer in 1867.^{3, 4} Clark, in 1860 noticed this condition among the natives of the Gold Coast and described it under the heading of "Dry Gangrene of the Little Toe."⁵

Up to 1905, only twenty cases of this condition had been reported in the United States.⁶ It has been reported in North Carolina by Harnaday and Pitman in 1881, and in Western Virginia in 1884 by Dubring.

The etiology of Ainhum is unknown and very little progress has been made toward arriving at any definite conclusion as to its causative factors. Theories of self-mutilation, wearing rings or tight bands, or bearing a relationship to leprosy may be dismissed as they have very little to substantiate them.

Wuncherer describes this as a form of tropho-neurosis. The question of heredity has been discussed by some writers. Da Silva Lima in his series of cases describes an entire negro family all the members of which presented this condition. Manson's own impression, supported by several others is "That it is provoked, at all events in the first instance, by wounds so easily inflicted on bare feet in walking through grass and jungle, and which through constant irritation, produced and kept up by wounds from sharp grasses and so forth, would in time give rise, especially in the dark skinned races so prone to keloid, to fibrotic changes of the derma, which might very well end in a sort of cicatricial contraction, and ultimately in a slow atrophying strangulation of the affected member."⁷

Castellani and Chalmers believe the condition to be one of parasitic origin—infection taking place probably through small superficial lesions or wounds which may be found in people who go around barefooted.⁸

Pathology—Dr. F. B. Mallory, of Boston, gives the following description of the pathological histology of this disease. "Sections show marked sclerosis of the arteries, with partial to complete obliteration of them, a little chronic inflammatory reaction and marked infiltration with mast-cells. Tubercle bacillus and Gram-Weigert stains for leprosy bacillus negative."⁹

Doctor Jimenez, roentgenologist, made the following report. "The most striking feature of the radiographs is the almost total disappearance of the middle phalanx of the little toe, of which there is only a very small fragment left, and of the proximal phalanx

only the proximal end is left at the metatarsophalangeal joint (The soft parts show a constriction amounting to almost complete detachment of the little toe at the digitoplantar fold. The phalanges of the other toes, in the diseased foot as well as those of the sound foot, show atrophic changes."¹⁰

According to Unna there is a primary degeneration of the skin, a sort of ring-formed scleroderma with callous formation of the epidermis, which by its seat at the base of the limb leads to a secondary total necrosis. There is an endarteritis by which the blood supply is gradually shut off to the distal part of the toe. The toe becomes oedematous and fatty while the bone undergoes a rarefying osteitis, so that the digit is gradually separated from the foot."¹¹ Wuncherer,¹² Schuppel,¹³ Dhuring,¹⁴ Eyles, and more recently

Darling have made extensive examination of the specimens of toes taken from patients suffering from anhum.

A most interesting resume is given by Dr. Henry Weinstein.¹⁵ "The epidermis is increased, the stratum lucidum slender, the papillary layer elongated, and in the rete Malpighii the pigment is found irregularly distributed. The constricting ring is made of dense fibrous connective tissue covered by a layer of epidermis. The process travels from the base at the constricting band, gradually to the top, involving all the structures in proper turn, and while the proximal parts show atrophy, the distal parts show degenerative changes.



FIG. 1.—Plantar surface of both feet with small toe of right foot missing

In the part distal to the constricting ring the pigmentary layer shows many germinal cells, while in the neighborhood of the ring the deeper layers of the skin show atrophy. The corium papillae are elongated, the surrounding capillaries dilated, and the perivascular lymph spaces are filled with corpuscular elements, especially young connective tissue cells.

The subcutaneous tissue is increased at the expense of muscle, tendon and soft parts, while here and there may be seen islands of fat cells. The sweat glands are very much atrophied and in the space between the glands there is much cellular infiltration, consisting of young connective tissue cells, fat and lymph cells. The original cells show cloudy swelling, together with granular and hyaline degeneration.

The blood-vessels are everywhere numerous, the larger arteries are engorged, all the coats thickened by the connective tissue replacement, including the proliferation of the subendothelial connective tissue, leading ultimately to endarteritis obliterans. The smaller arteries show very much thickening of the adventitia and much perivascular infiltration. The veins are dilated, thickened but empty. The lymphatics are also dilated and the lymph spaces in a state of engorgement.

In the bone there is a condition of rarefying osteitis, advancing from the periosteal side. The destruction in the interior is rapid, the cavities filled with reticulum of connective tissue, blood-vessels, numerous round cells and fat globules, the bone corpuscles being few in number. The ultimate result is the change of all the parts into dense fibrous tissue.

To summarize the pathological findings We meet first a condition of inflammatory œdema Later on there is found degeneration of original elements, followed by atrophy The highly organized tissue, such as sweat glands, blood-vessels, muscles and bone are all changed into connective tissue In all there are evidences of impaired nutrition due to pressure, vasomotor and trophic manifestations "

Symptoms—The disease is now considered purely a local disturbance Clinically the disease is characterized by the formation of a fissure which forms at the root of the toe, usually on the plantar surface



FIG 2 —Ring like constriction about small toe on left foot

The male negro subject and the fifth toe are most usually attacked Age is important as it is a disease of adolescence Cases reported in America have always had a history of African parentage

The fissure may appear on one toe, the other remaining sound or may appear simultaneously in both toes It tends to be symmetric The fissure deepens and spreads laterally and dorsally until the two wings connect which usually occurs on the dorsum of the foot

The toe eventually becomes completely encircled causing a strangulation The strangulation that ensues seems to depend upon the hyperplasia and growth of the epithelium plus the formation of a ring of fibrous tissue The skin is thick, dry and tough

If allowed to run its own course, this process may last from two to ten

years There are cases on record which have lasted from fifteen to twenty years

This strangulation is without pain at the beginning, but as the disease progresses may become very painful There is very little ulceration and practically no bleeding Beyond the ring of constriction the toe becomes enlarged and bulbous—presenting the appearance of a small cherry attached to the foot by a small pedicle Eventually the distal portion usually becomes



FIG 3—X ray findings at time of admittance

amputated spontaneously leaving a small ulcer which heals without trouble There are no constitutional symptoms

Treatment—There is no known treatment that will preserve the toe after the strangulation has progressed to any appreciable degree Facio recommends amputation as soon as diagnosis is made

CASE REPORT—The case to be reported here is the only one ever admitted to the Washington University Clinic, and as far as known, the first one ever reported in the State of Missouri The patient had been in this country all his life, his birthplace being Mississippi

B B, a negro, age forty-five, first seen October 13, 1922, complaining of bad toes Family history essentially negative Past history Noticed little toe on left foot began to get sore about a year ago It has become well and then sore again since that time On October 6, 1922, which is three days ago, dropped lump of coal on his left foot and since

then the toe has become very painful and almost constant in annoyance. He states that about one year ago he noticed a beginning constriction forming or tending to encircle the base of this left small toe. This constriction has been gradually progressing—becoming deeper and tending for the two ends to meet. He has been applying some medicine as prescribed by a physician.

The small toe of the right foot is missing—having been mashed off (he states) while working. (No history of injury—but states that for a year prior noticed a constricting band of the same character that is now present on the left toe.)

Physical Examination—Good pulsation in both anterior and posterior tibial arteries on left. Corns on toes at second and third phalangeal joints. Legs in good condition. Little toe of right foot has been amputated. Left foot first four toes bend under—little toe is greatly swollen. On under surface there is a constricting band more marked on under surface extending around entire toe.

Heart and lungs negative. Abdomen negative. Blood—hæmoglobin 86, red blood cells 4,200,000, white blood corpuscles 10,800, polymorphonuclears 60 per cent, small mononuclears 26 per cent, large mononuclears 6 per cent. Count—100 cells. Urine—negative for albumin and sugar. Wassermann—negative.

X-ray Findings—(Dr. Sherwood Moore). Anterior-posterior view of both feet. The ungual phalanx of the fifth toe on the right foot is lacking and the proximal one is the seat of great atrophy. The ungual phalanx on the opposite side is very narrow and thin and the proximal is extremely narrow. The proximal phalanges on the three outer toes of each foot have been very narrow shafts and very narrow medullary cavities. The second and third metatarsals on the left foot show deformity, suggesting an old fracture. The third with a rather sharp spur on its inner aspect. The second has a large sessile exostosis with two sharp projections, one forward and one internally, the whole giving an appearance as if it had articulated with the external sesamoid bone of the great toe. X-ray diagnosis. Localized bone atrophy of phalanges, old fracture of metatarsals—"Ainhum."

Treatment—Amputation at metatarsal phalangeal joint under $\frac{1}{2}$ novocain in usual method—skin sutured with silk (October 13, 1922). October 30, 1922, healed first intention.

Epidemiological Remark—This case is of particular interest because the patient is a native of this country and has never left the United States. An unsuccessful attempt has been made to get into communication with him since his discharge.

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A STUDY OF 520 CASES OF FRACTURES OF THE SKULL*

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WITH the steady increase in the number of accidents due to automobile and industrial injuries the study of a related group of cases becomes of interest, and as there has been no discussion of fractured skulls and intracranial injuries in this Society for several years, we are presenting as a basis for discussion an analysis of 520 cases treated on the First Surgical Division of Bellevue Hospital during the past eight years. The recent literature has been collected by McClure and Crawford¹ in their report of cases of head injury from the Harper Hospital. In addition, Vance² has recently published a most thorough study of 512 necropsies, and Beekman³ has reported 330 cases from the Childrens Surgical Service of Bellevue. Four hundred and thirty-five of our cases were men, eighty-five women, figures which correspond closely with Vance's of 445 and sixty-two, respectively. The sex incidence is of little interest from a purely medical standpoint, for men in their occupations, habits and customs are much more exposed and prone to bodily harm than are women. Furthermore, no attention has been paid to incidence by decades, for here again this means nothing, *per se*. Due consideration would of necessity have to be given to the tables of life expectancy in the various decades and also to the varying degrees of activity and exposure between a man of twenty to thirty and one of sixty to seventy. All of the cases reported here were in adults.

The causative agents were as follows:

TABLE I
Causative Agents

	Our cases	Vance
Automobile	110	189
Falls	179	156
Blows	62	33
Bullet	3	
Unknown	140	100
Street car	14	19
Train	3	
Crush	5	
Horse and wagon	4	

* Read before the New York Surgical Society, April 11, 1928

FRACTURES OF THE SKULL

The importance of alcohol as a factor has been difficult to determine. The patient in stupor or comatose as the result of an intracranial injury, given a drink by a sympathetic friend, may easily be noted as alcoholic by a house officer. Vance's finding of alcohol in the organs of 28 per cent of cases dying inside of ten hours is more accurate than any clinical observation.

TABLE II
Classification

Clinical grouping		III autopsies	Vance
Base	347	44	
Vault	90	15	36
Vault and base	57	52	471
No fracture	4		
Undetermined	22		
Compound	37		
Depressed	27		

A grouping of this sort is necessarily inaccurate but probably shows the most important portion of the fracture fairly well. In comparison with the autopsy figures it would indicate the higher mortality of the basal fractures.

In seventy-seven cases there were complicating injuries, seventeen of which were sufficiently severe to insure a fatal issue. The clavicle was the bone most often fractured—seventeen cases—while there were nine fractures of the femur, nine of both bones of the leg, and four each of the radius, ulna, and humerus.

On admission 178 cases were conscious and rational, 123 stuporous, 219 in coma. In almost all the conscious cases a history of unconsciousness of varying duration was obtained, very few patients in this series escaping without at least a slight concussion. One hundred and thirty-two were noted as being in shock, but as only thirty-five had blood pressures below 100, while forty-nine were specifically treated for shock, it is probable that most of these were victims of severe concussion rather than of true shock.

TABLE III
Blood Pressure on Admission

Below 100		35
Recovered	16	
Died	19	
100-150		313
Recovered	209	
Died	104	
Over 150		66
Recovered	31	
Died	35	
Not taken		106

The blood pressure readings were repeated at frequent intervals but changes were of less value in determining intracranial pressure than we had anticipated.

In individual cases the variation from one reading to another a few hours

later was very considerable, while often the readings did not check with the information derived from spinal tap, operation or autopsy

Pulse—The pulse on admission was below 60 in thirty-one instances. Twenty-one of these patients died, six after operation. The rapid development of increased intracranial pressure in these cases usually indicated lesions too extensive for control by operation or other means.

TABLE IV
External Signs of Fracture

Scalp wounds	216
Wounds communicating with fracture	37
Hæmatomata	147
Depression	27
Bleeding from ears	142
Bleeding from nose	104
Bleeding from pharynx	36

Scalp wounds and hæmatomata were of considerable importance in determining probable sites of skull and brain injury as well as of the location of contre-coup injuries. Wounds, however, led directly to fractures in surprisingly few instances.

Bleeding from nose or pharynx are of doubtful significance owing to the possibility of extracranial injury. In these cases local injury was so far as possible ruled out and there were other evidences of fractured skull. In a few cases the discharge from the nose was cerebrospinal fluid.

Bleeding from the ear through a ruptured drum is of much more significance. Once in a while it may occur as a result of drum rupture without fracture. Occasionally the line of fracture will pass into the external canal without involving the drum. We believe that patients bleeding either from the drum or from a laceration deep within the external meatus should be treated as fractured skulls, with the possibility of the development of meningitis always in mind.

TABLE V
Eye Signs

Pupils		
Equal, normal reactions		284
Recovered	231	
Died	53	
Fixed		164
Recovered	36	
Died	128	
Dilated		
Recovered	21	
Died	76	
Contracted		
Recovered	10	
Died	16	
Unequal		
Recovered	5	
Died	36	
Not recorded		72
Fundi		
Oedema or hæmorrhage		62
Normal		92
Not examined		366

FRACTURES OF THE SKULL

The fixed pupil was a serious sign. When unequal, the larger pupil indicated the side of the lesion with considerable exactitude. The conditions of the pupils often changed rapidly and in this way they were of considerable value in determining the patient's progress.

Examination of the fundi would probably show a larger percentage of changes if carried out as a routine and at frequent intervals. Anatomically, it is the simplest and most direct way of determining intracranial pressures, aside from the spinal tap. In the hands of the average general surgeon or interne, however, with an uncontrollable patient and without artificial dilatation of the pupils, the findings may be questioned. Nevertheless, we believe it to be a very important diagnostic sign, too often omitted, and also too often neglected during the period the patient is under observation. We cannot urge too strongly repeated funduscopic examination as a routine part of the treatment of all cases of intracranial injury.

TABLE VI
Neurological Changes

Cranial nerve paralysis		58
Recovered	44	
Died	14	
Spinal nerve paralysis		88
Flaccid paralysis		51
Recovered	3	
Died	48	
Weakness		37
Recovered	14	
Died	23	
Reflexes		
Superficial—Decreased		58
Deep		
Decreased		63
Increased		79
Abnormal		62
Convulsions		23
Recovered	9	
Died	14	
Negative neurological examination		127
Subjective changes		51
Vertigo		
Headache		
Irritability		
Drowsiness		
Vomiting		56

The cranial nerves most often involved were the seventh and eighth, less often the third and sixth, and least often the first. Discovery of injury to the latter was usually late, the patient often complaining of loss of taste and smell only on return to the follow-up—a commentary on the sameness of taste of hospital food.

Generalized paralysis or convulsions were an indication of severe concussion, associated with more or less brain laceration in all cases, and were of very grave prognostic significance. In these cases the coma was usually deep, the pupils fixed, blood pressure low, and death a matter of a few hours.

Localized weakness or spasticity—always sought for as indication for operative intervention—and accompanied by changes in reflexes, was of great

value in determining the site of injury. It was often impossible to tell whether the condition was due to extradural bleeding or to brain laceration as in this series the typical syndrome of epidural hæmorrhage was conspicuous chiefly by its absence.

The subjective changes noted were unquestionably too few, as practically all patients complain of headache, and at some time or other, if not in coma, present the irritability characteristic of meningeal irritation.

Vomiting has been of little importance. Projectile in only ten or twelve cases we have thought of it as due more often to alcohol than to trauma.

TABLE VII
X-ray Findings

Total examined		228
Negative (61%)	140	
Fracture of vault	75	
Fracture of base	13	

All of the cases reported as negative were confirmed by other means. The high percentage of negative reports is interesting in comparison with Beekman's figures from the Childrens Service, fifty-seven of one hundred and twenty-three cases with positive X-ray reports "having none of the classical symptoms of fracture," while in only 21 per cent of the cases X-rayed was there a negative report.

The technic—particularly in fractures of the base—is difficult, and demands a considerable number of exposures, while the interpretation of grooves that may be normal is at times a matter of difficulty.

When positive, the plates are of great value, but we have come to disregard a negative report.

TABLE VIII
Spinal Fluid

Total cases tapped		414
Bloody fluid	398	
Pus	3	
Clear	13	
Pressure		
Increased	209	
Normal	185	
Decreased	12	
Not noted	8	

There has been discussion of the advisability or safety of spinal tap in these cases, and emphasis has been laid on the danger of causing medullary pressure. We believe that this danger has been over-emphasized and that the advantages to be gained—both diagnostically and therapeutically—outweigh the risks. In this series the only complication has been the breaking off of a needle in one case, fortunately not in the canal.

The diagnosis in the cases with clear taps have been established by X-ray, operation or by the presence of cranial nerve paralysis.

While the presence of blood in the spinal fluid strictly speaking means only sub-arachnoid hæmorrhage—either from brain laceration or pial hæmorrhage—it is rarely found in traumatic cases without a fracture, and, as it is in itself

an indication of brain injury, should be considered an indication for treatment as a fracture—particularly if we realize that in treating a fracture of the skull we are using that terminology for convenience and from habit, and are in reality concerned with the treatment and course of the underlying brain injury

The amount of blood varied from a minimum only to be noted on standing to—in three cases—a fluid sufficiently bloody to clot in the tube. The fluid is drawn into three test tubes, and the test considered negative unless the third tube is at least as bloody as the first.

It is of interest, perhaps, to mention here a few of the patients in whom the injury was relatively slight and the symptoms evanescent. The common causative factor in this group was either a fall or a blow, following which the patient was stunned or knocked out for only a few moments and then complained only of headache of varying degree. On admission their physical and neurological examinations were entirely negative and their subjective symptoms rapidly subsided. Were it not for the information gained by spinal tapping they would have been classified merely as mild concussion. Here lumbar puncture with fluid uniformly bloody in all three tubes gave a more correct diagnosis.

At first, the pressure was noted crudely, by the rate of flow, more recently by the manometer. In 209 cases it was increased usually to from 20 to 30 mm, in one case to 50 mm. Unfortunately no accurate readings were taken in the cases in which it was noted as decreased.

While the amount of blood in the spinal fluid gave us little information as to the future course, the determination and correction of increased pressure was of great importance.

The routine treatment of this group comprised

Treatment—1 Treatment of shock 2 Physical examination with especial reference to eyes and neurological signs 3 Cleansing and exploration of scalp wounds 4 Blood pressure readings 5 Spinal tap 6 Ophthalmoscopic examinations of the fundi 7 Treatment of increased intracranial pressure

This, in the majority of cases, was controlled by one early spinal tap, with reduction of pressure to normal. When this was inadequate magnesium sulphate by mouth or rectum was used in the milder cases. We have used hypertonic solutions intravenously in a few cases, too few to have a considered opinion of their value, but with less satisfaction in the use of saline than glucose. In the more severe cases repeated spinal taps have been the most valuable method of treatment.

Twenty-three cases have required two taps, four a third and four a fourth. We have not hesitated to remove slowly enough fluid to lower spinal pressure to 10 mm. In no case has this required the removal of more than 50 c c of fluid.

Certain supportive and symptomatic treatment has also to be considered. For the unconscious patient an adequate supply of fluids must be maintained. This we have found to be most expeditiously accomplished by hypodermoclyses of normal saline or 5 per cent glucose solution. Very frequently

sedatives are demanded Here paraldehyde, sodium bromide, chloral hydrate, and luminal are the drugs most commonly used Particularly at first, with an alcoholic or delirious patient paraldehyde by rectum is especially valuable, and alternating with this chloral and the bromides may be administered in a similar manner Luminal has proved itself most useful and beneficial in our hands During the patient's stay in the hospital he is given a small dose three times a day and is instructed to continue it for two to four weeks or longer after his return home With its use we have felt that the irritability, headache, and dizziness have been less noticeable Other sedatives or hypnotics are used as indicated We do not use morphine primarily because of its depressant action on the respiratory centre, its diminution of the cough reflex, and because of its occasional unfavorable action with certain patients We do not hesitate, however, to employ it when indicated or if other sedatives fail

On discharge the patient is instructed to lead a very careful and well regulated life for a month or six weeks with long periods of absolute rest during each day

8 Rest in bed for three weeks

This is a difficult regulation to enforce, many patients seeing no reason for staying on after their immediate symptoms have cleared up Sixty-three left at their own risk after a shorter stay

9 Operation

TABLE IX
Operations

Total number		62
Pathology		
Compound	5	
Depressed	11	
Epidural hæmorrhage	21	
Subdural hæmorrhage	19	
Bullet wounds	2	
Mastoiditis	3	
Brain abscess following compound fracture	1	
Operation within 24 hours of admission		45
Recovered	20	
Died	25	
Operation after 24 hours		17
Recovered	11	
Died	6	

TABLE X
Operative Mortality

	Early operations		Late operations	
	Recovered	Died	Recovered	Died
Compound fracture	3	2		0
Depressed fracture	7	2	2	1
Epidural hæmorrhage	7	11	2	4
Subdural hæmorrhage	1	10	4	
Bullet wounds	2	0		1
Mastoiditis			2	0
Brain abscess			1	

Sixty-two patients (12 per cent) have been operated on, with thirty-three deaths (53 per cent)

Operation in the early stages, while the patient is still in shock or concussion, even in the presence of localizing signs, is probably unwise. It was done at times, usually with the discovery of a collapsed non-pulsating brain which did not expand with the removal of the clot and which in several cases had not expanded at autopsy.

It would seem that concussion in these cases was the cause of death, rather than pressure. When the patient recovered from concussion operation might be expected to have more favorable results.

The longitudinal sinus was torn in three cases, and successfully repaired by an aponeurotic graft in one.

TABLE XI

Mortality

Total (39%)		204
Within 6 hours	76	
6 to 12 hours	34	
12 to 24 hours	22	
24 to 48 hours	16	
Over 48 hours	56	

In the cases dying within twenty-four hours the picture was that of severe concussion, usually with no signs of local pressure. The patients were unconscious, the pupils fixed and usually dilated, occasionally unequal. Reflexes were abolished and there would be a generalized paralysis. Respiration was usually deep and stertorous, gradually becoming Cheyne-Stokes in type, while the pulse, never full and bounding, gradually became more feeble and rapid. Autopsy on these cases usually showed extensive brain laceration and not infrequently localized epidural or subdural hæmorrhage of which there had been no localizing signs.

In the later deaths, pneumonia was a factor in twenty-two, exhaustion in eight.

Meningitis occurred seventeen times, more or less evenly distributed among fractures of the anterior and middle fossa and compound fractures of the vault. Streptococci were found in two, staphylococci in two, pneumococci and B. coli each in one, an unidentified Gram-negative intracellular diplococcus in three, while in seven the organism was not found. One case recovered. In this a Gram-positive intracellular diplococcus was found repeatedly in a sero-purulent spinal fluid which gradually, without specific therapy, cleared up.

Thanks to the cooperation of the medical examiners we have records of autopsies in 111 cases.

TABLE XII

Autopsies

Fractures of vault	15	
Fractures of base	44	
Fracture from vault to base	52	
In cases dying within 48 hours		76
In cases dying over 48 hours		35

TABLE XII—*Continued*

Findings	Early cases	Late cases
Brain laceration	57	13
Laceration into ventricle	2	6
Epidural hæmorrhage	21 { 2 operated 19 not operated	6 { 2 operated 4 not operated
Subdural hæmorrhage	45 { 3 operated 42 not operated	11 { 2 operated 9 not operated
Torn sinus	4	1
Meningitis	0	8
Pneumonia	2	10
Exhaustion	0	2

The large number of epidural and subdural hæmorrhages is the striking feature of this chart, and led us to a review of these cases, with the feeling that cases had been missed that might have been benefited by operation. Of those with epidural hæmorrhage eight were found to be small and merely incidental to extensive subdural hæmorrhage and brain laceration.

TABLE XIII
Unrecognized Epidural Hæmorrhage

Epidural clot	Subdural clot	Brain laceration	Pupils	Neurology	Blood pressure	Pulse	Death
90 gm	Small		Equal react	Flaccid paralysis			6 hrs
240 gm			Unequal fixed	Hæmiplegia	104/40	70	3 hrs
130 gm		+	Unequal fixed	Bilateral spasticity	150/100		6 hrs
Large (right)	Large (left)	Deep	Equal react	Coma 7 days			12 days
48 gm		Deep	Unequal react	Flaccid paralysis	125/75	124	4 hrs
50 gm		+	Equal react	Generalized weakness, reflexes normal	100/80		24 hrs
100 gm (Posterior)			Equal react	Spastic arm reflexes normal	120/75	86	22 hrs
100 gm (Right Posterior)		+	Unequal fixed	Left hæmiplegia	120/60	60	8 hrs
175 gm		Hæmorrhage in basal ganglia	Dilated fixed	Flaccid paralysis, right and left Babinski			8 hrs
+	80 gm		Dilated	Left hæmiplegia	110/60		8 hrs
145 gm	+		Dilated fixed	Right, reflex left	120/50	50	12 hrs
70 gm	+	Extensive	Fixed unequal	Reflexes, hyperæsthesia, right and left Babinski		136	8 hrs
63 gm			Fixed	General spasticity	200/80	96	¼ hr
52 gm	32 gm	+ Hæmorrhage in lateral ventricle	Negative	No paralysis, right reflexes left	175/90		5 hrs

These cases might have been aided by operation, but in most of them concussion apparently prevented the development of localizing signs.

It is interesting to note of how little value the blood pressure and pulse rate was in the determination of intracranial pressure.

FRACTURES OF THE SKULL

In one other case there was a distinct hospital error—a patient treated for alcoholism and scalp wounds, sent home, and readmitted twelve hours later, moribund, post-mortem no intracranial injury other than a large epidural clot. This was one of the few cases in which the typical history of epidural hæmorrhage could be obtained.

Of the fifty-one unoperated cases showing subdural hæmorrhage at autopsy only five were noted as showing signs of brain compression. The largest clot measured weighed 250 gm., but two of 60 and 70 gm. caused definite pressure. One case showed localizing signs but died shortly after admission. In three repeated taps were done. All these died within twelve hours.

Of the 316 patients discharged, sixty-three left at their own risk while twenty-eight were discharged to other hospitals. No attempt was made to follow either of these groups. Fifty-seven disappeared and could not be traced. We have, however, been able to trace 168—146 non-operative and twenty-two operated cases.

TABLE XIV
Follow-Up of Non-Operative Cases

	Followed to				
	6 months	6-12 months	12-18 months	18-24 months	2 years +
No complaints	23	22	9	10	8
Dizziness	12	9	6	2	2
Headache	9	5	2	2	3
Tinnitus	4	1	1	0	0
Deafness	6	4	3	3	2
Other cranial nerve weakness	1 (VII)		2 (I)	1 (I)	1 (VII)
Extremity weakness	1				
Mental changes					
Irritable	2	1			
Nervous	3		3		
Melancholic				1	
Insane			1		
Epilepsy improved		1	1		
Died			1		

TABLE XV
Follow-Up in Operative Cases

	Followed to				
	6 months	6-12 months	12-18 months	18-24 months	2 years +
No complaints	4	4	1	3	1
Dizziness	2				1
Headache		2	1		
Motor aphasia	1				
Amnesia		1			
Blind in one eye					1
Nervous and irresponsible					1
Died	*1				

* Meningitis following revision of mastoid

Eighth nerve symptoms, dizziness, tinnitus and deafness were by far the most common sequelæ. The former were always most marked, or else only noticed, on sudden changes of position. To most of the patients it seemed to be an annoyance rather than a definite detriment to their well being. Tinnitus when present was complained of much more bitterly.

There is a definite tendency for symptoms to improve over a period of from eighteen months to two years but symptoms persisting after that time seem to be permanent. If the air injection suggested recently by Penfield⁴ is of value it will be in the treatment of this small group of patients with persistent headache.

The follow-up of the operated group is too small to be of value. About half of the recovered cases when last seen were free from symptoms, probably a smaller percentage of good results than in the other group, as might be expected, most of these cases having had more severe injuries.

SUMMARY

We have presented the review of these cases of Fractured Skull from one division of Bellevue Hospital. In studying it we have been impressed—and discouraged—by the high mortality of the early hours, a mortality due in most part to cerebral concussion and not to be controlled by the means now at our disposal. In the later hours more frequent use of lumbar punctures may be of value.

Operation in the first twelve hours, with the patient still in concussion is of little value, aside from the toilet of compound fractures. The depressed fracture is not of itself an urgent indication, while the epidural hæmorrhage, with its classical picture of unconsciousness, recovery, and gradually developing coma has in our series been a rarity.

Early and repeated lumbar punctures seem to be our greatest aid—and emphasize that in talking of fracture of the skull we are really concerned with the intracranial injury that lies hidden beneath the bone.

From our follow-up results it seems fair to draw the conclusion that 50 per cent of these patients will eventually make a complete recovery although final abatement of symptoms may not occur until eighteen months to two years after the initial injury. Concerning the persisting symptoms and complaints there is no doubt that compensation and legal complications play a definite rôle. When one of these factors enters it is almost impossible to separate the wheat from the chaff. Of the permanent sequelæ, vertigo is common but rarely more than an annoyance, headache is common and sometimes quite disabling. Deafness, tinnitus, and disturbances of smell and taste are not uncommon, while there is a small group in which the final outcome, though not fatal, is distinctly unfortunate.

This entire series of cases has been treated with considerable conservatism and operation has been performed only when it has seemed to us to be specifically indicated. This is in line with the experience and ideas of others in recent years. One should not lean too far backward, however, but should be

FRACTURES OF THE SKULL

constantly on the alert Intervention should not be delayed where the intracranial pressure remains persistently high in spite of repeated attempts at relief or in the presence of suggestive local signs after the patient has weathered the initial shock and concussion, for it is in these cases that the possibility of a masked epidural hæmorrhage must be borne in mind

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FRACTURE OF THE NECK OF THE FEMUR IN CHILDHOOD *

A REPORT OF SIX CASES

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OWING to its mechanical conformation the hip-joint must be susceptible to frequent injury at any age, yet the literature contains comparatively little reference to fracture of the neck of the femur in childhood. On the Chil-

dren's Surgical Service, Bellevue Hospital, we have treated during the past twelve months three cases presenting this type of fracture. A review of the records of this Service for the past ten years revealed only three other children in which a diagnosis of a fracture of the neck of the femur had been made. These six cases are here reported through the courtesy of the Director of the Service, Dr. Carl Burdick.

The youngest child was five years of age and the oldest sixteen. The fracture in all the cases was produced by severe violence. On admission only a moderate degree of disability was noted in all of the cases, which is quite



FIG 1—Case II. Original roentgenogram showing an oblique fracture along the cervico-trochanteric portion of the left femur.

characteristic of this fracture in childhood and is in marked contradistinction to the extreme disability observed in the adult. Case V, on account of the complaint of persistent pain in the knee, had been treated for several weeks for a "contusion to the knee" and had received during this interval roentgenograms and strapping of the innocent knee! Three of these cases

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were of the incomplete cervico-trochanteric variety which Taylor has called the "hinge type" and accounts for the slight shortening observed on admission. Two were of the complete cervico-trochanteric type and only in one case was the fracture through the narrowest portion of the neck. This last type is a very rare occurrence in childhood, this patient being only six years of age. Stimson shows in



FIG 2—Case III. Original roentgenogram showing an incomplete fracture at the base of the neck of the left femur.

his book a specimen of a case presenting a transcervical fracture reported by Bolton in a child eight years of age. The case reports follow.

CASE I—A boy, age eleven, fell from a truck on August 24, 1919, and was badly



FIG 3—Case IV. A. Original roentgenogram showing an incomplete cervico-trochanteric type of fracture with coxa vara. This patient refused any treatment. The subsequent deformity that developed is shown in the following roentgenogram of the case.

bruised. He was brought into Bellevue Hospital, complaining of pain in the left hand and hip. Examination showed that he presented abrasions about the left hip and thigh and movement of the hip caused pain. There was no shortening and roentgenogram of the left hip disclosed a "fracture of the base of the neck of the left femur without displacement." He was anesthetized and a Whitman abduction plaster spica applied. Two months after admission he was discharged from the hospital walking without a limp and presenting no deformity. A roentgenogram taken several years after injury shows an apparently normal hip-joint.

CASE II—A boy, age ten, on September 5, 1922, while roller skating was knocked down by an automobile and dragged about fifteen feet. He was brought into Bellevue Hospital, and examination showed multiple con-

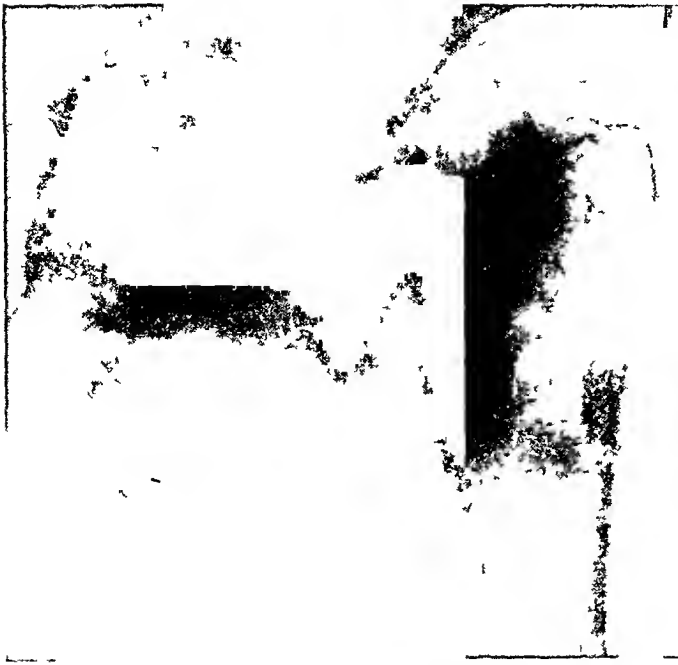


FIG 4—Case IV, 13 This case illustrates most strikingly the results of inadequate treatment. Rontgenogram shows the severe and disabling deformity which resulted

accident states that the child is walking "without limp and appears to have a perfectly normal hip"

CASE III—A boy, age five, on May 13, 1925, fell from a three story fire escape, injuring his head and left hip. He was brought at once to Bellevue Hospital. Examination showed left hip to be bruised and swollen. The trochanter was not elevated and there was no shortening but the limb was rotated outward, and there was pain on movement at the hip. Rontgenogram (Fig 2) showed a "fracture at the base of the neck of the left femur, incomplete cervico-trochanteric in type." The child was placed in a Bryant frame with the affected limb in abduction and four weeks later was discharged from the hospital without limp. Examination showed that there was no shortening or limitation of the movements of the hip.

CASE IV—A boy, age sixteen, on January 9, 1926, fell a distance of about fifteen

tusions about the body with pain on attempted movement of the left hip. The limb was rotated outward and there was shortening of one inch. Rontgenogram (Fig 1) disclosed an "oblique fracture along the cervico-trochanteric portion of the left femur." The patient was anesthetized and Whitman abduction plaster spica applied. Following reduction the roentgenological report showed that the anatomical position was excellent. The patient remained in the hospital six weeks and was removed to his home at the request of his family physician. This patient did not return for follow-up but the report one year after the



FIG 5—Case V Complete transcervical fracture of the neck of the right femur

FRACTURE OF NECK OF FEMUR IN CHILDHOOD

feet landing squarely on both feet. He immediately suffered pain in the left hip and was taken home. At this time he was told that he had bruised the left hip and stayed in bed for six weeks without other treatment than rest in bed. At the end of six weeks he became dissatisfied and came to the clinic at Bellevue Hospital, walking with the aid of crutches. He presented at that time pain on movement of the left hip, and one and a half inch shortening and the leg was rotated outward. A roentgenogram revealed an incomplete cervico-trochanteric type of fracture with a coxa vara deformity.

The lad would not enter the hospital and returned home. He was not seen for over a year and then on August 16, 1927, was admitted to the hospital on account of a recent automobile accident. At that time examination of the left hip showed that the left leg was rotated markedly outward, there was elevation of the trochanter and painful restriction with all movements of the left hip. The shortening was three inches. Rontgenogram (Fig. 4) revealed a fracture of the neck of the left femur through an old coxa vara deformity with marked eversion of the limb. In view of the age of this patient it was considered that bony union could be obtained without resorting to bone pegging, therefore the Whitman abduction method was applied and six months after application of the spica, firm bony union resulted.

At present the patient is walking about without the aid of cane or crutches. He has one inch and three-fourths shortening and presents marked limitation in all movements of the hip.

CASE V—A girl, age six, on May 30, 1927, fell down a flight of stairs injuring her right hip. She stayed in bed for a few days thereafter and then began to limp about, never complaining of much discomfort.

Three weeks after the original injury the child walked into the clinic at Bellevue Hospital, complaining of persistent pain in the knee. She walked with a marked limp, the leg was rotated outward, the trochanter was elevated and there was a shortening of the limb of one inch. There was limitation and pain on all movements at the hip-joint.



FIG. 6—Showing result obtained in case shown in Figure 5

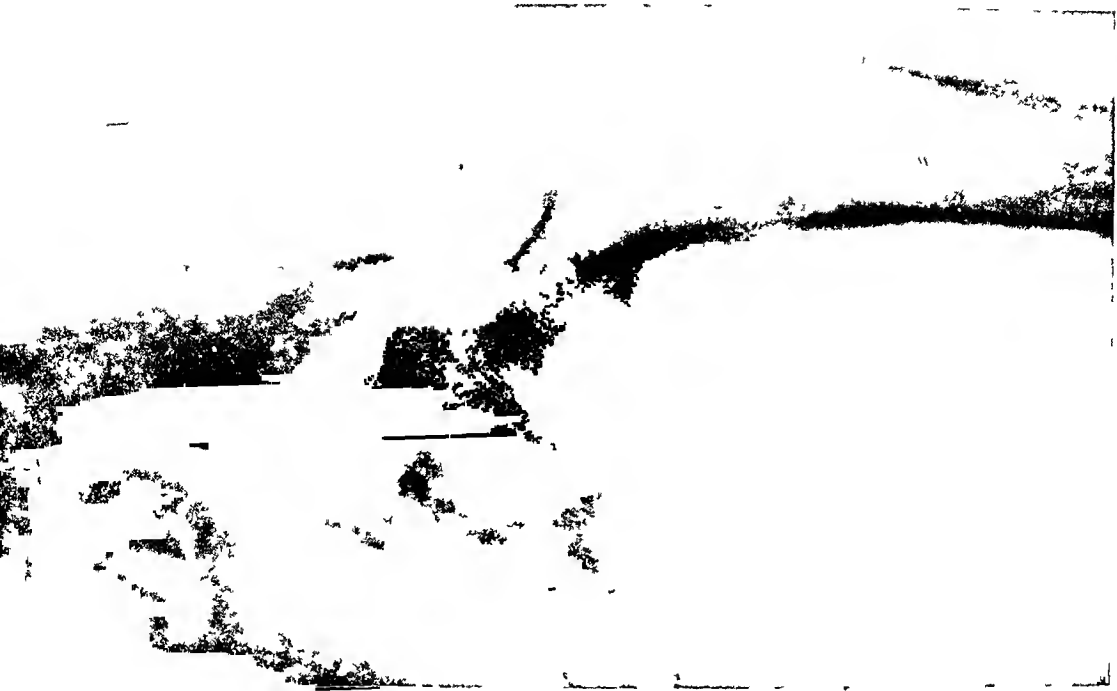


Fig 8—Case VI. Rontgenogram showing almost complete obliteration of the original fracture. This rontgenogram was taken seven months after the fracture.



Fig 7—Case VI. Rontgenogram showing a complete fracture at the base of the neck of the left femur.

FRACTURE OF NECK OF FEMUR IN CHILDHOOD

Rontgenograms (Fig 5) revealed a complete transcervical fracture of the neck of the right femur

The child was anæsthetized and plaster-of-Paris was applied after the Whitman abduction method. Evidently partial union had occurred at the site of fracture and a complete reduction of the deformity was not obtained. Patient wore this long plaster spica for two months and after application of a short plaster spica with the limb in the original attitude, patient was encouraged to bear weight. Even with the limb immobilized this length of time the callus was not firm and coxa vara developed on weight bearing. The limb was replaced in plaster-of-Paris in the abducted attitude. Plaster removed at the end of four months. At present the patient is walking about presenting the degree of coxa vara shown in Fig 6. Motions in all directions are satisfactory, abduction is slightly limited and there is shortening of one fourth of an inch.

CASE VI—A girl, age ten, on August 10, 1927, fell backward out of a window for a distance of six feet, landing on her back and right buttock, was brought the following day into Bellevue Hospital complaining of pain in the right hip. The right thigh was swollen and tender and the hip was slightly flexed and adducted. The trochanter was elevated and there was shortening of one inch. The leg was not rotated outward. Rontgenogram showed fracture at the base of the neck of the right femur (Fig 7). Under ether anæsthesia the fracture was reduced following the Whitman abduction method and a long plaster spica applied. Rontgenograms after application of the plaster show the perfect anatomical reduction that was obtained by the use of this method. The plaster was removed after three months and the patient was kept in bed, gradually obtaining full use of the limb, while receiving baking and massage. At present the patient is walking about without a limp. Examination of the hip revealed that the motions in all directions are essentially normal and shortening of only one eighth of an inch. As revealed by last rontgenogram of this case (Fig 8) the line of fracture is barely perceptible seven months after the injury.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD MARCH 28, 1928

The President, DR FRANK S MATHEWS, in the Chair

CANCER OF CERVICAL STUMP RESIDUAL TO SUB-TOTAL HYSTERECTOMY FOR FIBROID UTERUS

DR EDWARD D TRUESDELL presented a woman who was admitted to St Luke's Hospital, September 2, 1924, with a fibroid tumor of the uterus. A sub-total hysterectomy was performed. Her chief symptom prior to the operation had been irregular bleeding for nine months. There was no bleeding following the operation until August, 1925, when bleeding occurred which continued for two weeks. The patient then presented herself for examination. The cervical remnant was small, mobile and normal in appearance. There were no masses palpable at either side of the cervix or in the pelvis. The remnant of the cervix was removed, and upon microscopic examination this was found to present an epithelioma of the cervix. Patient is apparently perfectly well at the present time, more than two and a half years after operation.

In connection with this patient, Doctor Truesdell mentioned another who developed vaginal bleeding nine years after a sub-total hysterectomy for a fibroid uterus. This patient failed to return to her doctor until eight months after the bleeding had developed. There was obvious cancer of the cervix in the region of the external os. The cervical stump was removed by combined vaginal and abdominal operation, and apparently with success. However, there was prompt evidence of continuation of the growth, the patient dying some six months later.

DOUBLE EMPYEMA WITH SECONDARY THIGH ABSCESS ABOUT FOREIGN BODY

DR EDWARD D TRUESDELL presented a young woman who was admitted to St Luke's Hospital, June 30, 1924, with a diagnosis of double pneumonia and empyema. There had been an operation for acute mastoiditis two weeks before. It was noted in the history that seven years previously, at ten years of age, this patient had had a fracture of the shaft of the left femur treated by the application of a Lane plate, the plate having been removed six months later. A large empyema of the left chest was drained and a week later a similar condition upon the right side was drained. She was extremely sick, but slowly convalesced and during the course of convalescence a large swelling developed deeply situated in the left thigh and in the region of the old fracture. This was found to contain pus, and a large secondary abscess was drained in this region. X-ray examination showed the presence of a Lane plate screw superficially embedded in the shaft of the femur, which had served as the focus for the development of this abscess. This unfortunate complication occurring in the course of a serious sickness served to illustrate the possible consequences of operative treatment for a fracture of the shaft of the femur in children. Operations in such conditions have usually

FRACTURE OF HUMERUS

seemed desirable because of over-riding of the fragments and the fear of shortening of the extremity, if this over-riding is left uncorrected. Doctor Truesdell said that some six years ago he had presented before the Society five children showing elongation of the femur following fracture. He was then of the opinion, and his observation during these years has supported this opinion, that inequality of the lower extremities following fracture of the femur in children is due to lengthening, rather than shortening, of the injured extremity. For this reason apprehension of shortening can scarcely be regarded as an adequate indication for operative treatment.

MUSCULOSPIRAL PARALYSIS FOLLOWING SUPRACONDYLAR FRACTURE OF HUMERUS

DR HERMANN FISCHER presented a boy, age five, who was admitted to the Lenox Hill Hospital on August 24, 1927, a few hours after a fall from a height of about six feet, striking the ground with his right elbow. When admitted there was considerable swelling of the elbow-joint with subcutaneous blood effusion, considerable pain, inability of motion and crepitus.

X-ray examination shows a transverse fracture through the lower end of the humerus. The fracture is at the level of the olecranon fossa. The lower small fragment is displaced backward, and there is about one inch over-riding. Two attempts were made to reduce the fragments under narcosis, but were unsuccessful.

Operation, September 12, 1927. Incision about four inches long on the outer aspect of the lower end of the humerus and elbow. The muscles were carefully dissected to avoid injury of the musculospiral nerve, the periosteum was bared, incised and the bone fragments freed with periosteal elevators. Because of difficulty of getting them in proper alignment, a portion of the lower fragment of the humerus was removed. The bone fragments were not sutured, but were held in place by a careful periosteal and muscle suture. Skin closed with interrupted silk sutures. A molded plaster-of-Paris splint was put on holding the arm in extreme flexion and slight outward rotation.

Three days later was discharged from hospital to be treated in the orthopædic department of the dispensary.

Three weeks after operation it was noticed by the orthopædic department that a wrist-drop had developed and the child could not move the arm.

He was readmitted to the hospital and the following status was found. The wound has healed by primary union. There is 30 degrees of motion in the joint. A wrist-drop is present. Can extend end phalanges of fingers, but is unable to move fingers in metacarpal-phalangeal joints.

Diagnosis. Secondary musculospiral paralysis due to pressure of callus on nerve.

October 12, 1927 an incision was made over the site of the old scar, extending for about an inch above it. The muscles were separated until the musculospiral nerve was found. The nerve was freed along its course and in the region of the site of the fracture it was seen to be compressed by callus and scar tissue. The callus compressing the nerve was removed, at the site of compression, the nerve was flattened and had a grayish-yellow color. The triceps was split and the nerve imbedded in its fibres. The skin was then closed with silkworm gut.

The joint was mobilized and put up in extension in an anterior molded plaster splint. The wound healed by primary union.

Since the middle of February the boy has had full function of the arm.

DIVERTICULUM OF BLADDER

DR HERMANN FISCHER presented a man, fifty-four years of age, who was admitted to the Lenox Hill Hospital, November 2, 1927. At that time he complained of vague pains in the region of the bladder and of having to pass his urine a little more frequently than usual. During the last two weeks, however, he had to strain very much to void and occasionally the urine burned him and he had pain in the glans penis on micturition. This straining has caused a slight return of hemorrhoids which he had ten years ago. He never had any hæmaturia.

His past history and his family history are irrelevant. He has been in the hospital twice, once for an ulcer of the leg and at another time for a carbuncle of the arm.

He was a well-nourished male, not acutely ill.

Before his admission to the hospital he had been cystoscoped by Doctor Asch who had found a diverticulum on the left wall of the bladder near the opening of the left ureter.

Cystoscopy, November 2, 1927. Residual urine, 50 c c. bladder capacity, 150 c c. cystoscope was passed with great difficulty on account of a tight narrowing of the prostatic urethra and the internal sphincter. Bleeding was quite profuse. There is present a chronic cystitis with moderate trabeculation. The two lateral lobes of the prostate are slightly enlarged and irregular, leaving between themselves a narrow groove. The ureter openings and the diverticulum, seen by Doctor Asch previously, could not be brought into view on account of the bleeding. The patient refused further treatment and left the hospital unimproved. He was readmitted, November 7, 1927. His condition was unimproved, he suffered more pain and more difficulty in emptying his bladder. November 17, 1927, a suprapubic cystostomy was done under general anaesthesia. On opening the bladder its walls were found moderately hypertrophied. The prostatic gland was very little enlarged, but the internal sphincter was very rigid and fibrotic so that the finger tip could not enter into the prostatic urethra. A diverticulum was found situated above and a little to the left of the left ureteral opening. The depth of the sac measured $2\frac{1}{2}$ inches and the diameter of the mouth of the sac was about $\frac{1}{2}$ inch wide.

A circular incision was made around the opening of the sac, cutting through the wall of the bladder and thus separating the diverticulum from the bladder. Before the incision was made a ureteral catheter was inserted into the left ureter in order to guard against injuring this structure. The mouth of the diverticulum was then secured with a number of Allis clamps and by gently pulling and by blunt dissection with the finger and a gauze-sponge, the diverticulum was easily shelled out from the surrounding perivesicular tissue. A small cigarette drain was inserted into the cavity, around it the wound in the bladder was closed with two sutures of chromic gut, the cigarette drain, together with the suprapubic tube were led out through the cystostomy wound. The cystostomy wound was sutured with chromic gut in two layers around the drain and the tube and the abdominal wound closed around them. Five days after the operation the suprapubic tube and the cigarette drain were removed. The patient made a smooth recovery, his highest temperature after the operation having been 101.2. He was discharged from the hospital with a very small fistula which discharged only a few drops of urine occasionally.

He reentered the hospital, December 27, 1927, because his fistula had not entirely healed and he still had trouble with his fibrotic sphincter. The

JEJUNAL ULCER FOLLOWING GASTRO-ENTEROSTOMY

bladder was opened again, January 19, 1928, and the site of the previous diverticulum was carefully inspected. There was no scar to be seen in the interior of the bladder, only a small shallow dimpling could be seen where the old site of the diverticulum had been. The internal urethral opening was enlarged by removing a wedge-shaped piece from its posterior wall by the electric cautery. There was hardly any bleeding. After the operation a No. 28 F. sound passed easily into the bladder. Suprapubic wound was closed around a suprapubic tube and the bladder and abdominal wounds were closed around it.

JEJUNAL ULCER, GASTRO-COLIC FISTULA, FOLLOWING GASTRO-ENTEROSTOMY

DR. HERMANN FISCHER presented a man, age forty-five, who was admitted to the Lenox Hill Hospital for a "diarrhoea" of two months' duration, three to seven daily movements, also occasionally at night. No dietary indiscretion. He lost twenty-five pounds during this time. Appetite very good. No pain or vomiting. He had always been well until seven years ago when he had pain after eating, vomiting with considerable loss of weight. In a hospital in Italy, a pyloric obstruction, caused by an ulcer of the pylorus was diagnosed and a posterior gastro-enterostomy after Hacker was done in 1927. Since that time he has been symptom-free and has worked regularly as a stone cutter. He is a thin, undernourished man. Does not suffer from pain or discomfort. There is a linear scar in midline from ensiform cartilage to umbilicus, well healed and firm. No tenderness, no masses are palpable. The feces give a faint trace of blood. The gastric contents: Free acid, a c 16, p c 40. Total acid a c p c 58. Blood negative.

Röntgen Examination January 14, 1928. The stomach was large in size and somewhat ptosed, the lower border in the erect position extending about four inches below the iliac crest. The stomach presented a regular outline, and the rugæ appeared to be heavy, suggesting some hypertrophy. Peristalsis was very moderately active, and neither under the fluoroscope nor in the serial röntgenograms could a good cap be obtained.

At the sixth hour there was considerable retention in the stomach, the head of the meal reached the mid transverse. At the twenty-fourth hour the meal was distributed throughout the large bowel, which appeared to be quite markedly dilated.

A peculiar factor in this case was the transverse colon being filled with barium before the gastric series was finished, which means that, provided the meal went through its normal course it reached the transverse colon within an hour. A careful check-up on the plates shows no evidence of either a spontaneous or artificial gastro-colostomy. However, the fact that the meal was in the transverse colon so rapidly indicated some pathology in this region, and the possibility of a perforation between the duodenum and the hepatic flexure.

January 27, Röntgen examination of this patient by means of a clyster presents a very striking appearance. The medium passed up through the sigmoid, descending colon, and transverse colon as far as the hepatic flexure. From this point the stomach filled up and immediately began to empty into the small bowel so that we had the appearance of the large bowel lying under many loops of small bowel filled with barium, and the stomach completely filled out, as was seen in the plates taken at the gastro-intestinal examination.

January 31, Röntgen reexamination of the stomach of this patient showed a gastro-enterostomy functioning actively. This could not be made out at

the previous examination From here the transverse colon filled up The appearance at the present time suggests the communication to be in relation to the gastro-enterostomy rather than to the duodenum

Clinical diagnosis Gastro-colic fistula, caused by jejunal ulcer following a posterior gastro-enterostomy

Operation, February 4, 1928 Midline incision from ensiform process to umbilicus Many adhesions between stomach and anterior abdominal wall which had to be separated, there was also extensive adhesions between the large curvature of the stomach and the transverse colon and upper ileum On turning the stomach upward an inflammatory mass was found which was made up by the posterior wall of the stomach, the afferent and efferent loop of the jejunum and the transverse colon, all matted together by firm adhesions After careful dissection a fistula of the transverse colon was found of the diameter of a pencil which led into the stomach at the site of the gastro-enterostomy stoma The afferent loop of the jejunum was markedly hypertrophic and dilated, whereas the efferent loop was contracted and its lumen considerably smaller than that of the afferent loop The region of the stoma itself was hard and inflamed and was the seat of a chronic ulceration The fistula in the colon was excised and the gut was sutured The loop of jejunum was dissected away from the stomach and the ulcerated margins of the jejunum and the stomach were also excised The defect in the stomach as well as the defect in the small gut were closed by a double row of chromic gut

The pylorus was the seat of cicatricial contraction, the original ulcer having healed Therefore a pyloroplasty after Finney was done

The patient made an uneventful recovery and is well since the operation

Pathological report The walls of the stomach and gut are congested and cedematous, and show inflammatory cell-infiltration The mucous membrane in the region of the anastomosis shows superficial erosions apparently involving the gastric portions There is no evidence of malignancy

THE USE OF OX FASCIA IN THE OPERATIVE TREATMENT OF HERNIA

DR HENRY W CAVE presented a woman, thirty-three years of age who was admitted to Roosevelt Hospital, October 21, 1927, for treatment of a ventral hernia She had undergone an emergency operation for extra-uterine pregnancy in July, 1926, developed a hernia in the lower end of the wound two months later and after two weeks had another operation for repair of incisional hernia—both of these operations were done in a neighboring hospital—eight months later, she noticed the hernia had recurred in the same place Has been wearing a belt since first operation Until the past two months she has also been troubled with constipation and occasional nausea and vomiting Onset of menstruation since July, 1926, has been quite painful and also since this time she has lost about twenty-five pounds in weight

When admitted to Roosevelt Hospital there was a midline scar about 6 inches long below the umbilicus, in the centre of which is an opening which admits easily the thumb and through which a small knuckle of intestine tends to protrude when patient coughs—vaginal examination there is a thickening in either fornix particularly on the left—the uterus seems tender and slightly enlarged

October 24, 1927, the scar was excised and the loops of the intestine adherent in the sac and around the hernial ring were freed In examining the abdominal viscera it was discovered that there was a large mass in the region of the left tube and ovary, a typical left tubo-ovarian abscess This was removed without soiling A side-to-side closure was then done and a

good part of the tissue which had formed the sac had to be utilized for the muscles to either side were very thin and frayed, over this side-to-side overlapping procedure which was done with interrupted chromic catgut sutures, a strand of ox fascia suture was interwoven back and forth across the defect, widely spaced interrupted silkworm sutures closed the wound

She made an uneventful recovery Except for a seepage through the lips of the wound of the Scott's solution in which the fascia was preserved, there was nothing interesting to note Temperature rose to 101, first day post-operative, reached normal on the fourth day In bed twenty-three days Patient states that occasionally she has a pain in the right lower abdomen—digestion and bowels are regular—wound perfectly healed—when patient coughs or strains no bulging in the region of the scar either generally or locally

DOCTOR CAVE then presented a man, aged forty-one, who was admitted to Roosevelt Hospital, January 10, 1928, four months after having undergone operation for a bilateral inguinal hernia Soon after he was discharged from the hospital he noticed a bulging in the region of the left external inguinal ring—this bulging area has become gradually larger

When admitted there was a protrusion in the region of the lower angle of the scar on the left side and a very definite impulse is seen and felt on coughing near the pubic spine—without question it is a recurrent indirect inguinal hernia January 11, 1928, repair of recurrent left indirect inguinal hernia, retransplantation of cord, suture with ox fascia

Incision was made excising the old scar, fascia of the external oblique was identified and cord isolated, the sac identified, freed and found to be of moderate size, transfixed and ligated and excised The opening was quite large and the internal oblique muscle was hardly perceptible, its fibres being thin A strip of ox fascia was used weaving it back and forth from what remained of the internal oblique muscle to Poupart's ligament, cord transplanted, external oblique sutured over cord, closure of the wound with interrupted widely spaced silkworm gut sutures

The patient's temperature rose to 102.6 first day and gradually subsided to normal by the fifth day, a very normal course thereafter, out of bed on the nineteenth day, discharged on the twenty-second day

The man states that March 14 there appeared through a gap in the scar at the lower end of the wound a little pus A few drops of pus have been discharged through this opening during a period of three days, apparently a small abscess had formed at the lower angle of the wound, probably where the end of the suture was last tied—ring however firm, no evidence of any recurrence

DOCTOR CAVE added that these two patients were presented to show the moderate local and general reaction following the use of a dead fascial suture Sufficient time has not elapsed to assume a cure as all his cases (four) have been operated upon within the past year Except for (1) seepage through the lips of the wound of the preservative (Scott's solution) and (2) a small sinus persisting for a few weeks in one instance, which in all probability was due to the use of linen anchoring the end of the ox fascia suture, and (3) to a latent abscess which was of three days' duration in the last case presented, they have done as well as the ordinary hernia patient does following the use of any other type of suture There was practically no induration even in

the instance of the linen suture sinus or in the instance of the short lived latent abscess

The use of an ox fascia suture does away with an additional incision in obtaining fascia, as is done in the Gallie operation, no time is lost in obtaining a strand, a longer strand can be had than that which is obtained ordinarily in the McArthur procedure, especially in the instance of the operation for recurrent inguinal hernia

Koontz in Baltimore, following Nageotte, who transplanted pieces of alcohol preserved tendon to repair anatomic defects in tendons of living animals, has applied this same principle by the use of ox fascia in the cure of hernias. The histologic change that takes place is interesting. These grafts although dead do not act as foreign bodies, nor are they absorbed. The wandering cells of the host carry away the dead cells of the graft, the fibroblasts of the host invade the connective tissue framework structure of the graft and form living cells in the place of the dead cells of which the graft was composed. Then follows the establishment of a new circulation in the graft so that after a surprisingly short time the graft cannot be identified as a dead graft but appears, macroscopically, and microscopically, as a component part of the surrounding tissue. It has been asked why these ox fascia sutures are not exactly similar to the chromicized kangaroo tendon which were considerably used in former years and the chromicized catgut that is now used. Koontz maintains that the strands of kangaroo tendon and catgut are treated chemically, facilitating increased absorption, also that they are so twisted that the fibroblasts from the host cannot invade them, therefore they are absorbed by the host. Koontz has done seventeen hernias using ox fascia, up to last October. In two of his cases infections developed which he later proved to be due to the presence in the strips of fascia of nonpathogenic spores that had not been killed out by the preservative fluid. The total number of patients in which he had used ox fascia suture material have been eight.

DR CARL G. BURDICK presented three groups of patients representing the different types of inguinal hernia in which he felt fascial sutures were indicated.

In the first group there were two patients past middle life with large scrotal hernias of long duration and pendulous abdomens. In this type of hernia which is usually of long standing the inguinal canal has lost its obliquity, and the internal ring much enlarged and relaxed lies almost directly behind the external ring.

The first patient was operated on in July, 1927, at the age of fifty-seven, for a large scrotal sac which contained irreducible small gut and omentum, this was reduced with considerable difficulty after enlarging the internal ring by division outward. He developed a late infection which did not appear until a week after leaving the hospital. The wound discharged for several weeks but only a slight amount of his fascial sutures sloughed.

The second patient was operated on January 7, 1928, at the age of sixty-one, for a large scrotal hernia of forty years' duration. The posterior wall was very relaxed and to insure a more satisfactory closure the cord was

OPERATIVE TREATMENT OF INGUINAL HERNIA

divided Due to the adhesions of the sac there was a large area of induration above the testicle which is gradually subsiding

The direct hernias represent a second group in which a fascial repair is indicated as giving a higher percentage of cures than any other method With an absence of the conjoined tendon and a very weak transversalis fascia, this defect cannot be repaired satisfactorily in any other way in a fair proportion of the cases

The first patient age forty-two, had a saddle-back type of sac with the direct part of the sac predominating He was operated on in January of this year and while it is entirely too soon to say what his final result will be, he is presented as an example of this type of case

The second patient, age thirty-eight, was operated on in April, 1927, for a double direct hernia, right, size of egg, left impulse He developed an infection in his left wound which discharged for several weeks and the major part of his fascial sutures sloughed out Two months ago he developed a recurrence on that side Of a dozen cases which became infected, and in a few parts of the sutures have sloughed, this is the only recurrence which can be attributed to that cause

Recurrences form the third group in inguinal hernias and in these patients a fascial repair is always done

The first patient age thirty-five, was operated on six years ago for a right indirect inguinal hernia which recurred six months later He was operated on in January and an indirect recurrence found It is entirely too early to prognosticate a permanent cure, but from the feel of his scar one is quite confident that the result will be satisfactory

The second patient was fifty-nine years of age when operated on in April, 1926 He had been operated on five times before in as many years, the last two operations having been performed by New York surgeons of unusual ability A left direct sac the size of an orange was found with practically no posterior wall to his canal Obviously this defect could not be repaired without the aid of fascial sutures Two rows of sutures were used in the repair The first suturing transversalis fascia, transversalis muscle and internal oblique muscle to Poupart's The second suturing the external oblique behind the cord He has remained cured up to the present time

FASCIAL SUTURE IN THE OPERATIVE TREATMENT OF INGUINAL HERNIA (A PRELIMINARY REPORT)

DR HENRY H M LYLE read a paper with the above title for which see page 870

DR CARL G BURDICK said that the advantages of sutures over fascia lata graft had been demonstrated by Gallie who found that the union of the graft to the adjacent structures was by areolar or scar tissue, and while the graft itself might offer enough strength the weak point lay in its union to the adjacent tissues If a firm bite of the tissue was secured with the fascial suture this latter ultimately became a strong fibrous cord and held the tissues approximated securely

While he had used some ox fascia he felt that the latter was far from satisfactory at present Doctor Koontz had demonstrated satisfactorily that dead fascia provided a satisfactory suture material and later became organized in the tissues accomplishing the same results as the living sutures, but at present the sutures are very friable and poorly cut, As soon as these dis-

advantages have been obviated there was a broad field for the ox fascia. At the Hospital for Ruptured and Crippled they had been in the habit of preserving the extra living sutures in Scott's solution comprised of, alcohol 55, acetone 10, mercurochrome 2, distilled water 34, and when a case presented in which living sutures had not been obtained they used these preserved human sutures and have had satisfactory results with these.

Doctor Burdick disagreed with Doctor Lyle in regard to not overlapping the external oblique behind the cord, but if done it was essential to close the muscles tightly about the cord as it undoubtedly left a weak spot at that point in as much as the cord emerged through both layers of muscle at the same level.

Doctor Burdick had seen about a dozen late infections. These usually came on after leaving the hospital, in a few about the tenth day. What the cause was he did not know. Usually some of the fascia sloughed but only one case has been followed by a recurrence.

Personally he has operated on 149 inguinal hernias by this method in the past four years in the following groups: indirect 45, indirect with direct weakness 14, direct 61, recurrent 29. While these cases have not been followed as carefully as Doctor Lyle's he has observed the following recurrences, three indirect with direct weakness, one recurrent, one direct with sloughing of the fascial sutures due to infection.

DR MORRIS K. SMITH said that reports of the results in hernia repair with living fascial sutures deal largely with more difficult cases. Unquestionably these are the cases in which they are particularly indicated. Yet a comparison of the two types of suturing in the ordinary adult male hernia is of great importance first because it gives an index of the reliability of the method and second because results in ordinary inguinal hernia are not yet wholly satisfactory. Doctor Lyle's series, while it contains a higher proportion of the more difficult types of hernia, because he started the fascial suture in these cases, yet represents to a considerable degree the routine hernia work of the hospital as he began its employment some time ago in all adult males.

Doctor Smith had followed his lead in this matter and had been interested at this time to sum up his own results from the follow-up reports. Using a year's follow-up as the minimum except for such cases as have presented a recurrence earlier he had a series of fifty-five repairs with 10.9 per cent recurrences in which catgut sutures were used as opposed to thirty-four repairs with 2.9 per cent recurrences in which fascial sutures were used. Summary follows:

<i>Inguinal Hernia</i>		
	Catgut	Fascia
Indirect	39 (37 patients)	21
Direct	12 (8 patients)	10 (9 patients)
Recurrent	4	3
	—	—
	55	34

OPERATIVE TREATMENT OF INGUINAL HERNIA

	<i>Inguinal Hernia</i>	
	Catgut	Fascia
Recurrences		
Indirect	4	1
Direct	1	0
Recurrent	1	0
	—	—
	6 — 109%	1 — 29%

It is perhaps only fair to say that the catgut series was done earlier and therefore represents a longer follow-up, as well as a less mature period in operative experience

Of the fascial suture cases the Gallie was done in the recurrent herniæ and the McArthur in the remainder

These series are obviously too small to have much weight and yet they indicate a decided advantage for the fascial suture

The one recurrence in the fascial sutures series was in an indirect hernia in which the cord had been brought directly out subcutaneously At reoperation the recurrent sac followed out along the cord while the union of the conjoined tendon to Poupart's at its inner side was firm Doctor Smith now feels as Doctor Lyle does that suturing the aponeurosis of the external oblique behind the cord is unsound, surrendering the protective effect of the natural obliquity of the canal through the supporting structures of the abdominal wall

In deciding for or against the fascial suture method in hernia its applicability must be weighed The McArthur suture requires a longer incision and more time but the difference is small after a little experience The speaker had not found the McArthur method applicable to recurrent hernia owing to the scarring of the aponeurosis of the external oblique In these cases and in the more difficult direct herniæ the Gallie should be used

DR ALEXIS V MOSCHCOWITZ stated that he had performed a very fair number of operations for the radical cure of hernia without having to take recourse to the Gallie technic, he was not even tempted to do so Furthermore, both he and his patients were satisfied with the results obtained Doctor Moschcowitz does not wish to say that the Gallie technic has no place in surgery, but he does believe that the indications for it are very rare and that it should be restricted to those cases in which there is a loss of substance resulting in a large defect in the abdominal wall, in other words, there is no frequent indication for it in the inguinal and femoral varieties of hernia

For a number of years Doctor Moschcowitz has discarded entirely the use of muscle for the repair of inguinal hernia For the sake of better technic he goes so far as to extirpate the cremaster muscle entirely and when the internal oblique and transversalis muscles present themselves in the wound, he has them retracted In other words, Doctor Moschcowitz uses for the repair of hernia only the aponeurosis of the external oblique and Poupart's

ligament In femoral hernia he utilizes only Poupart's ligament and Cooper's ligament

Doctor Moschcowitz assumes that he has had just as many recurrences as other surgeons, but in a careful follow-up of his private patients he has seen but one definite recurrence, and even that was not a bona fide recurrence because the new hernia was of the femoral variety

Up to June, 1927, Doctor Moschcowitz was extremely partial to kangaroo tendon in the repair of hernia He has, however, seen so many infections follow its use that, although no patient developed a recurrence, he has abandoned its use entirely and is again using chromicized catgut

DR WILLIAM CRAWFORD WHITE said that he had reserved the use of living fascia suture for the more difficult cases, and in these the aponeurosis of the external oblique was practically always so weak that it was necessary to use fascia lata In fifteen cases followed over two years he had had three slight recurrences But it must be remembered that these cases were of the desperate type and with the old methods would have given a higher recurrence Doctor Lyle's most interesting observation was that he has convinced himself by his results that the routine use of living fascia has reduced the percentages of recurrences that he formerly obtained with a similar technic and the use of catgut

DOCTOR LYLE, in closing, said that the McArthur technic is so simple when mastered that it only takes a few minutes longer than suturing by catgut A study of the recurrences in the Halsted modification has shown that it violated the physiological principle of muscular control of the inguinal canal The external ring is brought close to the internal and the obliquity of the canal destroyed In addition the bringing out of the cord so straight offers a mechanical barrier to the proper shutter action of the arched fibres of the internal oblique and keeps them from coming down into the proper protective position over the cord and internal ring A secondary reason is that it also hampers the gliding mechanism of the external oblique muscles in its valve-like closure and consequently does not as effectively raise and set Poupart's ligament This is an important factor in an overhanging abdomen They were now using some form of fascial suture as a routine and so far they had found it more reliable than catgut Regarding Doctor Moschcowitz remarks about suture of the transversalis fascia being sufficient for all cases, he did not agree with him

Doctor Lyle said he takes particular care to obtain a functional closure of the transversalis fascia but in addition he added every detail which he thought would give a stronger functioning inguinal closure In many of the different cases the transversalis fascia could not be found or was useless as a barrier In these cases it is idle to say that the suture of the transversalis fascia would cure the hernia He reminded Doctor Moschcowitz that it is possible also to cure hernia without any suturing In the middle ages there was a monastery which had obtained fame for curing hernia and the patients

POST-OPERATIVE MASSIVE COLLAPSE OF LUNG

flocked from all Europe for treatment After scarifying the hernial region the leg was flexed on the abdomen and the knee bound to the opposite shoulder, the patient was kept in this position until firm union was obtained This position relaxes Poupart's ligament, the external oblique the internal oblique and conjoined tendon, the recti and healing took place without suture He would not advocate this as a sound procedure, nor did he believe it would ever become a very popular one

In conclusion he said that one cannot expect a fascial suture to take the place of sound surgery and he did not wish for a moment to leave that impression The endeavor is simply to find out if its use will improve results He was conscious that in having his attention more closely focused on the subject he might unconsciously be more painstaking in these cases He emphasized the fact that no case under eighteen years of age is included in this series

STATED MEETING HELD APRIL 11, 1928

The Vice-President, DR EDWIN BEER, in the Chair

POST-OPERATIVE MASSIVE COLLAPSE OF LUNG

DR CHARLES E FARR presented a boy four and one-half years of age, who entered St Mary's Free Hospital for Children, November 14, 1927 He had been ill twenty-four hours with typical signs and symptoms of a severe appendicitis and spreading peritonitis Operation was performed at once under ether narcosis by the open cone The appendix was gangrenous and there was a wide-spreading peritonitis The wound was left wide open and drained with the Gibson-Mikulicz tampon It was noted that during the anæsthesia there was considerable cyanosis The following day there was a very sharp reaction The peritonitis seemed, however, to account for this There was some cough, considerable dyspnœa and a moderate cyanosis On the third post-operative day there was a very marked degree of shock The temperature rose to 106.6, the pulse to 160 The cyanosis and dyspnœa was very great

Physical examination showed on inspection a much less expansion of the right thorax Marked hyper-resonance of the left chest Displacement of the heart to the right, and many changing signs in the right chest Dulness, bronchial breathing, moist and dry râles were scattered indiscriminately apparently The clinical diagnosis of massive atelectasis was made The child, who had been in the Fowler position was then laid flat, turned on the sound or left side and restrained in that position He fought vigorously against it, and coughed considerably In two hours his temperature had dropped from 106.2 to 102.2, and the pulse from 160 to 124 He was very much improved Oxygen was administered to relieve the cyanosis and this also aided The following day temperature dropped to 101 and the pulse to 120, and he made an uninterrupted recovery, the peritonitis slowly subsided and wound healed in about three weeks He was able to leave the hospital in four weeks and is now perfectly well

X-rays, taken on the fourth post-operative day, showed collapse of the right lung almost complete, with the heart, mediastinal contents and trachea, displaced to the right, and a very marked expansion of the normal left lung X-rays taken on the fifth post-operative day, two days after the onset of the collapse, showed the heart in a midline practically normal position, almost

complete clearing of the right thorax, trachea in the midline, and the left lung normal. X-rays taken ten days later showed complete return to normal.

This case was presented as being the only one of massive atelectasis in a child which has been recognized. It is highly probable, however, that many other instances have passed as pneumonia, bronchitis, etc. Unless X-ray is taken promptly at the onset of symptoms the diagnosis is apt to be missed.

DOCTOR FARR then detailed the histories of two more cases of massive collapse of lung from the service of Dr. Charles L. Gibson, of the New York Hospital, First (Cornell) Surgical Division.

Michael F., twenty-one years of age, entered the hospital, January 13, 1928. He was operated upon for recurrent attacks of appendicitis. He was given a general anæsthetic of nitrous oxide and ether without other medication. There was nothing noteworthy in the course of the operation. On the first post-operative night there was a cough, increase in temperature and respirations, with some cyanosis. Diagnosis of massive collapse was made by means of clinical signs and was confirmed by X-ray, which was taken on the second post-operative day. The report reads "Examination of the thorax shows marked opacity of the entire left chest and quite marked deviation of the trachea, heart and mediastinum to the left side. The findings indicate a massive collapse."

The House Surgeon, Dr. Wade Duley, on his own initiative, placed the patient on the right, or sound side, and slapped him vigorously on the left, or affected side. The patient became very cyanotic, gagged and coughed up a large amount of mucus. The condition immediately began to improve, and an X-ray taken thirty minutes later showed a very definite clearing of the shadow of the left lung, indicating that the lung had become aerated. The trachea was almost in the midline, the cardiac shadow was still displaced to the left. X-ray taken the following day showed some mottling in the left lung still present. The cardiac shadow was still somewhat displaced to the left. The trachea was almost in its normal position. The massive collapse had been relieved and had not returned. This patient made an excellent post-operative recovery and left the hospital on the tenth post-operative day with wound soundly healed.

The second patient was a young man, twenty-eight years of age, who entered the New York Hospital for acute appendicitis of twenty-four hours' duration. He was operated upon at once and an appendectomy was performed. There was no pre-operative medication. He was given nitrous oxide and ether by the closed method. The operation lasted fifty minutes. There was no noteworthy occurrence during or immediately after the operation. Twenty-four hours later his temperature rose to 103.2, pulse 116, and he became cyanotic and showed dyspnoea. The typical signs of massive collapse of the right lung were present. By X-ray the clinical diagnosis was abundantly confirmed. The right lung was collapsed, the trachea was well to the right side, heart almost entirely in the right chest, and the left lung was compensating. The patient was then turned on his left or sound side and the thorax struck sharply with the palm of the hand. There was no distress, but he coughed up a considerable plug of thick mucus. The relief was immediate. He was kept fifteen minutes on this side and coughed up a little more mucus. X-ray taken thirty minutes after the first X-ray showed the trachea in the midline, heart in normal position, right lung completely aerated, left lung normal. A plate taken twenty-four hours later confirmed the complete recovery.

SARCOMA OF BREAST

DOCTOR FARR presented these latter two cases as instances of the severity of the condition known as massive collapse or massive atelectasis. Of the nine cases which have been observed in the service of Doctor Gibson, who fortunately have been healthy young adults and mostly males, there have been no deaths, but the morbidity has been prolonged seven or eight days. The condition is most distressing to the observer and to the patient. This manoeuvre of Doctor Duley's has immediately cleared up the state of massive collapse and has returned it to a normal post-operative condition.

SARCOMA OF BREAST FIVE YEARS POST-OPERATIVE

DR CARL EGGERS presented a woman who, when forty-seven years of age, was admitted to the Lenox Hill Hospital, complaining of a swelling in the left breast which had gradually developed during the last six months. There had been no pain and no discharge from the nipple. There was no history of injury to the breast. She had, in her early life, nursed two children but had had no trouble with her breasts at any time. Past and family history had no bearing on the condition. Examination showed a fairly healthy woman with no disease of the internal organs to be made out.

The right breast was small and soft and showed no abnormality. The left one was large, it hung lower than the right, and the superficial veins were dilated. There was no retraction of the nipple. Palpation showed a large, hard tumor occupying the entire anterior portion of the left breast. It had none of the signs of carcinoma of that size. There was no discharge from the nipple and the axillary lymph-nodes were not enlarged. There was one area of softening in the tumor about the size of a walnut which was interpreted as due to cystic degeneration. On account of the lack of elevation of the breast, the absence of retraction of the nipple, the absence of pigskin appearance, the presence of large veins, and the absence of axillary lymph-nodes, the probable diagnosis of sarcoma of the breast was made.

Operation was performed September 13, 1923, the usual radical mastectomy procedure was carried out, removing both pectoral muscles and the axillary contents. It was possible to approximate the skin edges and get a good suture line. One split tube rubber drain was inserted into the axilla through a stab wound.

The patient made an uneventful recovery. The wound healed by primary union and she was discharged fifteen days after operation, entirely healed.

The pathological examination showed a spindle-celled sarcoma of the breast originating in the stroma of an intracanalicular fibro-adenoma. The following is a detailed report of the microscopical examination. Sections obtained from different parts of the tumor show an intracanalicular fibro-adenoma, the stroma of which is very cellular and in places has undergone sarcomatous degeneration. In a part of the tumor the epithelium is fairly abundant and the intracanalicular fibrous plugs and the surrounding stroma are very cellular and show myxomatous changes. Large areas of the growth are devoid of epithelium and consist of spindle cells which are either loosely arranged or are packed close together. In areas they are arranged in bundles which often anastomose with one another. The tumor cells show a general uniformity in size and but little irregularity in staining properties. Here and there are slightly larger and more deeply staining cells. Mitotic figures are not uncommon. The tumor shows considerable oedema and areas of mucoid degeneration.

The patient has been seen in the last few years at regular intervals at the Follow Up Clinic and at no time has there been any evidence of further involvement. She has remained well except for the development of a toxic

adenoma of the left lobe of the thyroid for which she was subjected to operation April 9, 1927, under local anæsthesia. She made an uneventful recovery.

RESECTION OF SIGMOID FOR ACUTE SIGMOIDITIS AND DIVERTICULITIS

DR CARL EGGERS presented a man who was first seen by him in November, 1923. The man was then forty-four years of age. He complained of attacks of pain in the left lower abdomen which he had had on and off for a number of years. During the last six months they had been more frequent. The pain was quite severe and remained localized in the region of the descending colon. It was never accompanied by vomiting. Bowels were fairly regular, but lately his stools had not been well formed, they had been thin and ribbon-like. He had not noticed blood. He had much trouble with gas which seemed to stick on the left side. There had been no loss of weight.

General examination was essentially negative. The abdomen was not distended. There was a little tenderness over the left lower quadrant but no tumor could be felt. Rectal examination was negative.

A diagnosis of malignancy or diverticulitis was considered and he was sent for Röntgen examination with the following result. There was no evidence of obstruction to the inflow of the barium mixture. The patient was able to retain the usual amount of fluid without any appreciable discomfort. Fluoroscopy and plates showed no evidence suggestive of any neoplasm, but presented evidence of very great spasticity and tenderness along the descending colon. Evacuation of the enema fluid was good. The appearance of the junction of the sigmoid and the descending colon was suggestive of diverticulitis.

(Barium Meal 24 hours p. c.) Typical appearance of diverticulitis of sigmoid and lower part of descending colon. Moderately diminished motility.

Conclusions. Diverticulitis of junction of descending colon and sigmoid causing marked spasticity of the descending colon and partial obstruction to the Barium mixture given per os.

After this diagnosis of diverticulitis had been established advice was given him about diet and proper care of the bowels. He was not seen again until a little more than three years later when he was admitted to the Lenox Hill Hospital, December 2, 1926, complaining of pain in the lower abdomen, which had started suddenly two days before at 3 A. M. The pain was sudden, severe and sharp, it was located in the lower abdomen just above the bladder. He got up and urinated and moved his bowels a little. The bladder was somewhat relieved but the pain remained severe. He did not vomit. He went to business the next day but returned early in the afternoon on account of severe pain. Was seen by a physician who made a diagnosis of acute appendicitis. When there was no improvement with conservative treatment the man was sent to the hospital. There was no urinary disturbance. He had had a chill the day before admission.

On admission he gave a history of frequent attacks of pain in the lower abdomen since last seen by the reporter three years before, but none as severe as the present one. His tongue was coated but moist. Heart and lungs were negative. The abdomen was distended, no organs were palpable. There was marked tenderness over the entire lower abdomen with rigidity which seemed most marked over the lower right rectus. There was no tenderness over either iliac fossa. Rectal examination was negative. Temperature 100.8. Pulse 96. White blood cells 16,400, polymorphonuclears 74 per cent. Immediate operation was advised and performed that evening.

A five-inch suprapubic incision was made just to the right of the median

line A large injected appendix was exposed and removed The sigmoid was then exposed In the upper part it looked fairly normal, but attached to it were several diverticulæ containing hard concretions On following the gut downward free turbid fluid was encountered Later culture showed this to contain colon bacilli and hemolytic streptococci This fluid surrounded a hard mass situated in the sigmoid at its lower end or near the upper end of the rectum It was about the size of a tangerine and very hard After exposure it was found to be acutely red and the fat overlying it oedematous It was covered with fibrin deposit Adherent to it was a loop of small intestines, likewise covered with fibrin It did not seem wise to separate the fat from the sigmoid for fear of causing a perforation A cigarette drain was therefore placed on the outer side of the inflammatory mass and brought out of the lower end of the wound The loop of small intestine was separated from the tumor and the omentum placed over the entire mass of coils of small gut, thus separating them from the tumor Abdomen closed in layers

The convalescence was quite stormy for a few days on account of a complicating broncho-pneumonia affecting the right side Sero-purulent drainage from the wound continued for a while and the drain was gradually shortened and finally removed December 14, twelve days after operation The patient was discharged cured December 25, 1926, twenty-three days after operation

During his stay in the hospital, a barium clysmia was given which showed marked diverticulitis of the sigmoid

The patient was seen from time to time after operation He continued to have severe attacks of pain over the lower abdomen, lasting for several hours at a time There was never any blood He was never entirely free from pain and was unable to lie on the affected side He was finally readmitted to the Lenox Hill Hospital March 1, 1927, about three months after his last operation That evening he had another attack of excruciating pain accompanied by a state of shock which looked alarming After he had recovered from that, radical operation was proposed and done, March 4, 1927

A left rectus incision about seven inches long was made No free fluid present No adhesions found as the result of the recent attack of peritonitis, except that the omentum was somewhat adherent to the scar Exposure of the affected area was rather difficult because the lower end of the omentum was adherent to the tumor mass, and the latter was also adherent to the lateral pelvic wall The sigmoid was then drawn upward and all adhesions freed One small abscess was then entered, evidently due to perforation of one of the diverticulæ For a distance of about four inches the sigmoid felt infiltrated and hard, as if it contained a tumor, but it was acutely red as at the previous operation About five inches of the sigmoid were resected, staying close to the affected portion in order to be able to do an anastomosis later One long diverticulum, not inflamed, happened to be in the line of incision It was dissected out and sent to the laboratory The ends of the gut were then united by silk sutures, using continuous for the inner layer and interrupted for the outer one Good approximation was obtained One cigarette drain was inserted on the outer side of the anastomosis

The post-operative course was very satisfactory for the first few days except for a persistent cough He passed gas within the first twenty-four hours His abdomen was soft and there was only moderate sero-sanguineous drainage from the wound, without odor A pneumonia developed at the right base and was associated with distressing cough On the morning of the fifth day the patient began to complain of severe pain on the left side of the abdomen His pulse was 120 and the abdomen was distended whereas the day before it had been soft and the pulse slower There was moderate

amount of discharge. He had desire to move his bowels. Rectum contained much feces. An irrigation gave a good result. There were several small movements afterward. Some of the fluid came out of the drainage wound above. He began to vomit. Obstruction was suspected, probably due to separation of fascia as the result of constant cough. The skin sutures had held intact, but a few were removed and inspection showed bulging of the gut. The entire skin wound was therefore reopened later in the day, exposing retracted fascia and bulging loops of gut matted together. They were cleaned, iodoform gauze was laid over them and then a plain gauze tampon. The wound edges were firmly strapped. Gastric lavage given. Hypodermoclysis. Patient looked bad. No passage of gas.

The following day the condition was somewhat improved. There were several small bowel movements, but the abdomen remained distended. He vomited frequently, but it was not fecal. The next day conditions were decidedly better. Bowels moved and vomiting ceased. Some fecal discharge presented at the wound, and a drainage tube was therefore inserted to replace the cigarette drain. Convalescence was uninterrupted after that. The separation of the wound required considerable attention. The patient was in no condition to stand a secondary suture and it is questionable whether it would have held. Holding the gut back by means of a narrow tampon and strapping the wound edges snugly over this gradually led to healing with a good firm abdominal wall. The patient was discharged cured April 3, 1927. He has since been well and has had no further attacks of abdominal pain.

An X-ray taken of his colon showed slight narrowing at the site of anastomosis, but no obstruction, and the bowels were in normal position and presented an entirely regular outline. On defecation excellent emptying took place.

The examination of the specimen showed the wall of the sigmoid much thickened and firm in feel. Pressure on it caused exudation of fecal masses from many diverticulæ. After emptying them, little everted openings like mouths were visible on the mucosa.

Microscopical examination showed two kinds of diverticulæ, true and false, the former having all the coats of the intestines represented in their covering, while the latter had walls consisting of mucous membrane, a definite muscularis mucosa and outside of that a zone of fibrous tissue. There were also areas of suppuration surrounded by dense inflammatory fibrous tissue containing bundles of smooth muscle, and groups of foreign body giant cells were found. The gut wall was much thickened by fibrosis and localized hyperplasia of the smooth muscle.

RESECTION OF STOMACH FOR JEJUNAL ULCERS AND OTHER COMPLICATIONS

DR CARL EGGERS presented a man who, when forty years old, came under observation October 24, 1924, on account of abdominal pain. He gave a long and complicated history. For many years he had been troubled with pressure sensation and fulness in the upper abdomen which never completely yielded to medical treatment. There was no vomiting and he had never had pain. About seven years ago he came under the care of a surgeon who made a snap diagnosis of ulcer, and without Röntgen or other examination operated through an epigastric incision. After operation the patient's wife was informed that an ulcer had not been found, that there was nothing serious, and that the appendix had been removed. Thirteen days after operation he was reoperated for what was diagnosed as intestinal obstruction. After

recovery from this he felt relief for several months, but then developed pain in the epigastrium regardless of whether he ate or not. There was much nausea but no vomiting. Medical care gave no relief. After a few years he gradually became worse. About two years ago he was operated on by another surgeon, also without previous X-ray examination. At this time the pylorus was resected and the open end implanted into a loop of jejunum. He was discharged two weeks later, but on account of constant vomiting he had to return to the hospital three days later when another operation was performed and an entero-enterostomy done to overcome a vicious circle. Since this last operation the patient had not had one comfortable day. He had pain all the time which during the last four months had become so bad that he was hardly able to walk. Pain was felt in the epigastrium and back. Fasting relieved it somewhat, but about one-half to three-quarters of an hour after meals it became excruciating. It was always worse at night than during the day. He had a great deal of belching, but no sour eructations, and no regular vomiting. His bowels were constipated and moved only every two or three days, with laxatives or an enema. He had lost fourteen pounds during the last four months. He had been unable to work for some time on account of pain. Since the last operation three Rontgen-ray studies had been completed at different laboratories. He had been informed that the pictures showed nothing.

The patient was a thin, anemic, sickly looking man with an anxious expression. The general examination was essentially negative. The abdomen was not distended, the scar well healed. No organs were palpable. Splashing sounds were heard over the upper right abdomen and there was marked tenderness over the upper right rectus. The man was sent to the Lenox Hill Hospital for observation and study.

At the hospital his weight was found to be 118 pounds. Not much additional information was obtained by observing him. He complained much of pain and desired relief badly.

October 28, 1924 Operation. Excision of old epigastric scar. Dense adhesions of stomach, liver and small intestines to the anterior abdominal wall were found. They were difficult to separate and it was difficult to interpret the findings. Careful investigation showed that a Polya operation, ante colica, had apparently been done. An enormously distended loop of small intestines presented, which was found to be continuous with the pyloric end of the stomach. It was found that about ten inches below the pylorus there was a wide intestinal anastomosis, which apparently functioned all right, but this anastomosis and some of the gut below it had herniated into a pocket.

The stomach was not dilated, but its walls were hypertrophied. There were no adhesions except toward the pyloric end. There was no evidence of ulcer. A long loop of jejunum had been drawn up in front of the colon and used for a Polya operation, the afferent loop being attached to the lesser curvature and the efferent to the greater curvature. Instead of gastric contents emptying into the descending loop they emptied into the ascending loop and had brought about tremendous dilation and hypertrophy. The descending loop was collapsed and ribbon-like. It was possible however to invert the wall of either loop into the pylorus, the opening of the large end easily admitting a thumb, and that of the small end the tip of an index finger. Between the two there was a definite spur which no doubt produced difficulty.

Evidently this condition had developed soon after the resection operation, and the surgeon at that time had tried to overcome it by an anastomosis between the dilated afferent and the collapsed efferent loop. In this he had but partly succeeded. The hypertrophy and dilatation extended beyond the

anastomosis into both loops of gut, but chiefly into the afferent loop toward the fossa of Treitz

As no ulcer was found the reason for the patient's present symptoms were considered to be the extensive adhesions and the herniation of gut which brought about an incomplete obstruction. The adhesions were therefore carefully separated and the gut then placed in a position as near normal as possible, pulling the transverse colon into position in such a way that half of it projected beyond the loop of small gut on either side. It was not believed that a gastro-enterostomy or another intestinal anastomosis could help the condition. The abdomen was carefully closed, bringing the peritoneal surfaces together separately by means of continuous chromic gut.

The wound healed by primary union and the patient was discharged, November 14, 1924, seventeen days after operation, almost completely relieved of his symptoms. However, the improvement did not last long. He was again seen May 27, 1925, when he complained of severe burning and cutting pain in the right side of the abdomen external to about the middle of the abdominal scar. He stated the pain was terrible and he was unable to work. There was no vomiting. His bowels moved daily without medicine. A tender swelling was noted at the site of the pain, but its nature could not be determined.

Medical treatment had no effect, but for fear of another operation he waited until July, 1925, when he stated that he suffered intensely and would rather die if he could not be relieved. Had been unable to work for a long time. He always referred his pain to one spot, just external to the umbilicus. A very tender, flattened, mass was palpable there which seemed to be attached to the abdominal wall. Operation was advised and performed July 16, 1925.

The old scar was excised. Intestines and liver were adherent to the anterior abdominal wall. While separating the small gut a hole was accidentally torn into it and repaired at once. A hard tumor mass was encountered adherent to the abdominal wall, at the place to which he had referred his pain. It felt like an ulcer or a carcinoma. In order not to tear into it the parietal peritoneum at the site of attachment was removed with the tumor. Examination then showed that they were dealing with the pyloric end of the stomach and its anastomosis with the jejunum, evidently a jejunal ulcer. With great difficulty the tissues were separated for identification and the condition was then found to be essentially the same as at the previous operation, except that the descending loop of gut was somewhat larger than before. A diagnosis of penetrating gastro-jejunal ulcer was made, and resection decided on with a posterior gastro-enterostomy by the Billroth II method.

The stomach was divided and turned downward over the colon. Proximal end closed. The two limbs of the gut were divided through the entero-enterostomy and the opening closed, giving thus a continuous gut. A posterior gastro-enterostomy was then done with the jejunum, proximal to the division, and suture just completed, so that a regular posterior short loop gastro-enterostomy had been produced. In removing the specimen it was found to be adherent posteriorly to a drawn up portion of the hepatic flexure, evidently the site of another penetrating ulcer. In separating them the colon was not opened, but a purse-string suture was taken for safety. The lower abdomen was found free from adhesions. The gall-bladder was normal.

The patient was quite shocked by the operation which lasted almost four hours. Hypodermoclysis had been given during the operation and under appropriate treatment he recovered satisfactorily.

The convalescence was uneventful, and he was discharged August 5, 1925, 20 days after operation, completely relieved of his symptoms. He has since

complained on and off of nausea, which is quite annoying, but he has had no pain. He is careful with his diet, but eats everything.

An X-ray examination made January 31, 1927, shows normal filling of the stomach with no deformity. The meal left the stomach very rapidly through the stoma of the gastro-enterostomy, so that at the end of three and one-half hours it had completely emptied. At the sixth hour the meal showed normal advancement into the large bowel.

DOCTOR EGGERS expressed the opinion that this case apparently showed that it is not immaterial how a loop of intestine is attached to the stomach. In this case the loop had been so placed that the ascending portion was at the lesser curvature, and all or nearly all the food was emptied into this portion, producing an enormous dilatation with a vicious circle and requiring an entero-enterostomy for its relief.

GASTRO-JEJUNO-COLIC FISTULA

DR CARL EGGERS presented a man, thirty-three years old, who was first seen by him February 5, 1927. The chief complaint was diarrhoea, associated with loss of weight and strength. The man had to move his bowels ten to twelve times in twenty-four hours, chiefly during the day, but also two or three times during the night. Stool was always thin, never well formed, it was light in color and had a bad odor. No blood had been noted. Movements were not associated with pain or cramps. During the day he was able to control them quite well, but at night they would pass like gas, requiring constant use of a napkin. Since early childhood he had been subject to occasional upset stomach associated with acidity, which was always promptly relieved by a little alkali. As he got older, these attacks continued and were especially severe after drinking alcohol. A dilated ptoed stomach was diagnosed by means of the Rontgen-ray. It was negative for ulcer. With one of the attacks, about ten years ago, he had some hematemesis, and a surgeon was called into consultation who diagnosed ulcer and urged immediate operation. A gastro-enterostomy was performed the following day. He did quite well after that except that he still had his occasional stomach upsets until five years ago, at which time, without premonitory signs, and without any pain he suddenly developed diarrhoea, which in the beginning kept him up all night. There was no blood noted. In spite of treatment it continued, sometimes a little less, then again worse. He lost weight and strength rapidly. About six months after onset, while carrying a heavy case he suddenly became dizzy, he had slight pain in the region of his stomach, but it did not last long, there was an urge to move his bowels and when he reached the toilet he passed a large amount of blood, which shot out of his rectum. He was so weak that he remained in bed for a week, but there was no return of bleeding, and he had had none since. The diarrhoea however has continued until the present. In the course of the years he was seen by a number of physicians, various diagnoses were made, and various treatments instituted without relief. There were periods when he was hardly able to walk. Rontgen-ray examinations had been negative. Under rest treatment and rectal irrigations he finally gained a little weight. A recent X-ray examination gave the following findings —

"The stomach is of about normal size, carrying a high situated anastomosis, which functioned well most of the time, occasionally a spasm would keep the anastomosis shut. The antrum formation was normal. The duodenum could be filled by manipulation, the bulb showed a definite deformity. During fluoroscopic examination it was noted that already about ten minutes after the ingestion of the barium there was some of it in the colon. To clear

up the situation a colon enema was done, which showed the sigmoid colon to be very redundant and wide, as well as the descending colon. At the splenic flexure the barium flow stopped for a short while, and when it continued, it had subdivided into two streams, running parallel for a while from left to right, and leading into the stomach and the transverse colon respectively. The enema was then stopped in the interest of the patient. The conclusion was that a gastrocolic fistula existed between the stomach and the splenic flexure."

On the basis of this he was referred to the reporter for operation. The man was a tall, anemic, thin man weighing 128 pounds. General examination was negative for organic disease. The abdomen was flat. There was no tenderness or rigidity and no mass was palpable. Rectal examination was negative.

Operation was postponed for personal reasons for a month. During the month the patient continued to lose weight and when admitted to the Lenox Hill Hospital, March 7, 1927, he weighed only 115¼ pounds. A transfusion of 500 c c of blood was given and operation was performed March 9, 1927.

Median epigastric incision. Stomach and omentum found extensively adherent to old scar, which adhesions had to be separated before the affected portion could be brought into view. The pyloric end of the stomach was completely buried in a mass of adhesions beneath the liver and could therefore not be visualized. The anterior surface of the stomach looked fairly normal. The stomach was of normal size. The lower border and posterior surface was adherent. The jejunum was about double its normal size and the walls were thickened. A wide communication existed with the transverse colon which passed just in front of the gastro-enterostomy and was closely adherent to the jejunum and the stomach. Whether a separate opening existed between the stomach and the jejunum or whether the whole thing was one large opening from the stomach into the small gut as well as into the colon could not be definitely made out. The colon proximal to the fistula was much larger than that distal to it. The peritoneum overlying the anastomosis was oedematous. In view of the uncertainty of the patency of the pylorus, it was decided to divide the colon on either side of the anastomosis, close all four ends and then unite the upper with the descending colon. This plan was carried out. Colon divided about one and one-half inches from the anastomosis on both sides. Ends closed by continuous silk and then buried by a purse string over which were placed interrupted sutures of silk. Good closure obtained. The midportion thus remained attached as a blind pocket to the jejunum and stomach. It was well supplied with blood and was about four inches long. The proximal colon as well as the splenic flexure were then mobilized sufficiently to bring them together by a lateral anastomosis without tension. Good opening obtained, easily admitting two fingers. Abdomen closed.

The patient recovered well from the operation, he had been given a hypodermoclysis during the operation and such administrations of water were continued. He passed gas during the first twenty-four hours. There was no vomiting. On the second day a little water was allowed per mouth, and the amounts increased from day to day. Bowels moved spontaneously a week after operation, and the stool was formed normally as it had not been for years. There were no symptoms in reference to the stomach, the portion of colon attached to it apparently had taken on gastric function and emptied promptly with the rest of the stomach.

A Rontgen examination made subsequent to operation showed the bismuth meal to leave the stomach by way of a deformed duodenum and also by

OPERATION FOR CARCINOMA

way of the gastro-enterostomy stoma. There was slight six-hour retention. A barium clysma showed a well functioning colon.

The patient was discharged from the hospital, April 6, 1927, about four weeks after operation. He had gained ten pounds during his stay. He has remained well since.

DR ALBERT E. SELLENINGS presented an X-ray and described a case in which, five years following a posterior gastro-enterostomy for pyloric obstruction, there appeared a sudden and persistent diarrhoea which later was accompanied by foul eructations. There was no pain and no abdominal cramps. Clinically the diagnosis appeared to be that of a jejuno-colic fistula. Subsequently the opaque enema demonstrated the communication. At operation dense adhesions were encountered, but in the final dissection there was found in the jejunum about one and one-half inches distal to the gastro-enterostomy stoma, an opening which communicated with the transverse colon. Examination of the stoma revealed no pathology. The openings in the jejunum and colon were closed with two rows of suture. It is now sixteen months since the operation and the patient is free of all symptoms and has gained forty pounds. He is observing a strict ulcer diet. The clinical diagnosis of jejuno-colic fistula should offer no special difficulty. As may be gathered from the literature, it would appear that the X-ray findings are not constant in revealing the condition. A gastro-jejuno-colic fistula may call for a rather extensive surgical procedure, but it is believed that in the jejuno-colic type, simple closure of the fistulous tract is the most justifiable.

FOUR YEARS AFTER RADICAL OPERATION FOR CARCINOMA OF THE FLOOR OF THE MOUTH

DR CARL EGGERS presented a man who was admitted to the Lenox Hill Hospital, April 15, 1924, being then forty-two years of age. He complained of a swelling of the floor of the mouth which had gradually developed during the previous three months. A biopsy had been done by his family physician a week previously and a report of squamous-cell epithelioma had been made. The patient was a well nourished, healthy looking man whose general examination was negative.

Examination of the mouth showed the upper surface of the tongue to be clean. His teeth were in poor condition. On the floor of the mouth, just at the frenum, there was a hard, irregular, ulcerated mass which extended on both sides of the median line and on to the under surface of the tongue. The tongue was freely movable. The tissue immediately surrounding the ulcer was somewhat indurated. On the right side, a small granulating wound was noted, evidently the site of the biopsy. The submental lymph-nodes as well as the superficial cervical lymph-nodes on both sides were somewhat enlarged, but they did not feel unusually hard.

Radical removal of cervical lymph-nodes and bilateral block dissection was done, April 17, 1924, under colonic oil-ether anaesthesia. A transverse incision was made across the front of the neck at the level of the hyoid bone from one sternocleidomastoid muscle to the opposite one. A vertical incision was then added on either side extending from the ear lobe almost to the clavicle. A short median incision was made from the middle of the transverse one upward to the margin of the chin. The flaps thus outlined were dissected back leaving the platysma in contact with the lower ones by keeping it attached to the underlying tissue above. A block dissection of the neck was then carried out in great detail working on both sides at the same time, and removing the submental, submaxillary, superficial, and deep cervical lymph-nodes, down to the clavicle. The entire specimen was removed in one

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piece The skin was closed with interrupted silk and a split tube drain was inserted on either side through a stab wound behind the sternocleidomastoid muscle

The patient made an uneventful recovery The wounds healed kindly but there was a little fluid collection along the suture line from time to time so that the second operation could not be performed until eighteen days later, when the neck wounds had entirely healed

Under colonic anæsthesia, May 5, 1924, the ulcerated area was lightly cauterized and then completely excised by means of Paquelin, keeping well beyond the margins of the tumor In order to do that the remaining teeth had to be extracted and a part of the under surface of the tongue had to be taken away An iodoform gauze tampon was packed into the wound and fastened to the outside by means of a silk thread On the second day the gauze packing was removed without causing bleeding and the wound was thereafter kept clean by mouth washes On the sixth day there was moderate bleeding from the wound due to separation of a slough It was easily controlled by cauterizing with silver nitrate, and packing with an iodoform tampon After that there was no untoward complication and the patient was discharged healed May 22, 1924, five weeks after his first operation

The pathological examination showed no tumor involvement of any of the lymph-nodes removed from the neck The microscopical examination of the mouth lesion showed the following Sections of the tongue tumor show a squamous-celled epithelioma of typical structure It is composed of columns and islands of squamous epithelium supported by a relatively small amount of compact cellular stroma The epithelial columns show a tendency to break and often anastomose with one another The epithelium is for the most part well differentiated and shows cornification and epithelial pearls Mitotic figures are numerous The tumor is very vascular and the stroma is richly infiltrated with inflammatory cells The growth extends deep into the substance of the tongue though it does not perforate it The tumor is surrounded by a rather wide margin of uninvolved tissue

The patient has been seen frequently in the Follow Up Clinic and he has at no time showed any evidence of metastatic involvement Although the tip of the tongue is missing and the tongue itself is rather fast, his speech is good and he has no difficulty whatsoever

TYPHOID CHOLANGITIS AND CHOLECYSTITIS WITH MILIARY ABSCESSSES OF THE LIVER

DR HAROLD E SANTEE presented a woman, aged forty years, who had been in Bellevue Hospital repeatedly

Her first admission was as Para IX to the medical service, from July 28 to August 7, 1923, with observations of fever, vomiting and a palpable spleen with an indefinite feeling of mass in the right upper quadrant of the abdomen She was thought to have typhoid fever although Widal, urine, blood and Wassermann were negative She was at full term and was delivered two days after admission All the symptoms disappeared promptly after delivery

April 7 to May 7, 1925, she was again in the hospital, five months pregnant, with complaints of fever, headache, diarrhoea, epigastric pain and vomiting She showed rose spots and a palpable spleen Her urine contained typhoid bacilli Her blood showed white blood cells 3,500, polymorphonuclears 50 per cent Blood culture was twice negative Symptoms subsided and she went home

July 16-August 7, 1925, she returned with a recurrence of symptoms and positive Widal After the birth of her baby her symptoms gradually sub-

sided, although she was sick at home for some weeks after her discharge with weakness and swelling of the legs. She then remained well and had another baby, number eleven, in December, 1926. This baby died, although confinement and puerperium were normal. About three months later she began to have anorexia and diarrhoea of seven to eight movements a day. This was followed in three weeks by jaundice, gradually increasing, and its associated symptoms, and she was readmitted to the medical service, March 14, 1927. At this time she was showing jaundice of moderate degree with a liver edge palpable one inch below the costal margin and in the right upper quadrant under this edge could be palpated a firm, irregular, tender mass about the size of an egg. Temperature ranged about 100, pulse 92. The blood examination showed hæmoglobin 80 per cent, red blood cells 4,800,000, white blood cells 6,800, polymorphonuclears 50 per cent. Blood pressure was 135 over 80.

Her condition gradually became worse. She was observed for six weeks before operation. Her temperature gradually became elevated to 103, then 104, with daily spikes averaging one and one-half degrees. Pulse remained relatively low. Spleen became palpable. Blood culture and stool culture three days after admission were negative for *B typhosus*. Jaundice decreased at intervals only to increase again. After sixteen days, her icteric index was 84, Van den Berg reaction showed direct-delayed positive, indirect-positive. The Graham test at three weeks failed to visualize the gall-bladder. At four weeks the Widal was positive in all dilutions, the blood culture was negative, the blood examination showed hæmoglobin 70 per cent, red blood cells 3,500,000, white blood cells 6,800, polymorphonuclears 50 per cent. Five weeks after admission and just after transfer to surgical service, the stool culture was reported positive for *B typhosus*. At this time temperature was continuing about the same but clinically the jaundice was decreasing and was only slight at the time of operation.

Operation, April 25, 1927, revealed a dense mass of adhesions over the gall-bladder fossa, binding the liver, transverse colon, omentum and duodenum to the gall-bladder. Dissection was difficult but final exposure showed a very thick-walled, contracted gall-bladder containing two stones about 1.5 cm in diameter. A little bile, of normal appearance, was present. The cystic duct was patent. The common duct was about 1 cm in diameter but contained no stones on palpation. The liver itself showed on its anterior surface numerous small subserous abscesses. Puncture of two of these about the size of a pea showed thick, grayish, purulent material. Cultures from the stones and the bile showed *B typhosus*. Culture from the abscess showed *B typhosus* with some staphylococci—possibly contamination.

In view of the evident patency of the cystic duct, a tube was placed in the small, rather mutilated gall-bladder and the omentum brought over the gall-bladder. With a cigarette drain to Morrison's pouch the wound was closed.

Following operation the temperature subsided gradually and the patient improved progressively. Three days post-operative, the bile showed *B typhosus*. Ten days later it showed colon bacilli. The tube was left in the gall-bladder for twenty-three days then removed. The sinus gradually decreased in size. Bile appeared in the stools in good quantity and culture of the stools was repeatedly negative for *B typhosus*. Each time the gall-bladder fistula closed, however, a marked shoot of temperature to 103 or 104 resulted. For this reason, she was held in the hospital until August 14, 1927, when she was discharged home in good general condition but with a small gall-bladder fistula unclosed and intermittently draining large amounts of bile.

October 11, 1927, she was readmitted to the surgical service for her biliary fistula. Operation, October 21, 1927, was in the nature of an exploration to determine the cause of the sharp fever when the fistula closed and to institute proper measures for a cure. After injection of the sinus with peroxide and methylene blue, the tract was followed down to the gall-bladder region. The gall-bladder was thick and fibrotic and in the region of the ampulla lying in a small pocket contiguous to the common duct was a stone surrounded by a small amount of grumous material. The gall-bladder was removed and a probe could be passed directly from the region of the stone into the common duct and duodenum and upward apparently into the right hepatic duct. Due to the disturbed anatomy of the parts, however, it was impossible to say definitely whether this opening into the common duct represented the stump of the cystic duct or a perforation just below it. The hole in the common duct was lightly closed and the wound closed with drainage to Morrison's pouch and the bed of the gall-bladder. Cultures from the gall-bladder showed colon bacilli and staphylococci. Examination of the liver during the operation showed a thin, normal looking capsule with no evidence of the milary abscesses present at the original operation.

Following operation by six hours, the patient vomited some of the methylene blue-stained mixture. She was in considerable shock and was transfused. Her general condition gradually improved but her local condition was discouraging as from the fourth day on, she began to discharge bile profusely from her wound. The stools became clay-colored and for five weeks, practically no bile showed grossly in the stools. Then she showed one light yellow stool and following this the stools intermittently showed bile. The sinus continued to show a profuse but slowly diminishing biliary discharge. December 9, 1927, she was discharged home with a biliary fistula and the feeling that when this fistulous tract had fibrosed sufficiently it might be necessary to transplant its superficial opening into the stomach or otherwise shortcircuit it. Much to the relief of the surgeon, however, she reported to him one month ago with this fistula completely closed and feeling well and happy.

MULTIPLE OPERATIONS FOR DUODENAL, MARGINAL AND JEJUNAL ULCERS

DOCTOR SANTEE presented a man who was forty-three years old when admitted to Bellevue Hospital, February 8, 1918, with a typical duodenal ulcer history of eight years' duration. Rontgenological examination showed an ulcer of the first portion of the duodenum. Operation, February 12, 1918, showed an indurated ulcer an inch in diameter, one inch beyond the pyloric vein on the anterior surface of the duodenum. This was folded in by a double purse string of chromic gut. A no loop posterior gastro-jejunostomy was then done by Doctor McQuillan using no clamps and absorbable sutures. An Ewald meal before operation showed a free acid of 68, total of 86. No test-meal was given after operation. Convalescence was satisfactory and he was discharged, March 8, 1918. A follow-up note three years later, in February, 1921, states he had no gastric symptoms but was constipated.

March 10, 1926, he was readmitted with a history of eight months of "distress" in the stomach, relieved by vomiting and less marked when bowels moved regularly. An Ewald meal brought nothing back after one hour. Operation, March 16, 1926, revealed a chronic perforating marginal ulcer with a deep sacular crater jutting out into the right leaf of the mesocolon.

about the stoma. This was palpated through an anterior gastrotomy opening, as was the pylorus and first portion of duodenum. No evidence of old duodenal ulcer except a slightly thickened scarred area was made out. It was thought to be healed. The gastro-enterostomy was undone by the reporter and the stomach, jejunum and mesocolon closed to approximate the normal as nearly as possible after the marginal ulcer had been excised. The patient was discharged, April 11, 1926. Just before discharge he showed in the Ewald meal a free acid of 65, total 80. He also complained of some "burning" after eating.

September 9, 1926, he was readmitted, complaining mostly of hemorrhoids but also of considerable gastric distress after meals, more marked for the past two months. He was on a medical régime for one month and then transferred to the surgical service. His hemorrhoids were remedied under spinal anaesthesia. September 22, 1926, or six months after his previous gastric operation, an X-ray examination showed an ulcer of the first portion of the duodenum with a small six hour retention. October 15, a serial stomach test showed free HCl as follows: half hour 40, hour 74, hour and one-half 89. Five days later, another test-meal showed as follows: 55 minutes, free HCl 60, total 75; 80 minutes, free HCl 75, total 90; 110 minutes, free HCl 45, total 80.

Operation, October 29, 1926, revealed a small duodenal ulcer on the superior aspect of the duodenum, just distal to the pylorus with adhesions of duodenum to the liver. A subtotal resection of the stomach from just proximal to the pyloric ring back through the pars media was then done and a posterior gastro-jejunal anastomosis made after suturing down from the lesser curvature about 3 cm. After this operation the patient did very well and went to the Burke Foundation in good general condition, December 10, 1926. He did not return to the Follow Up Clinic.

In December, 1927, Doctor Santee was invited to be present at a final operation upon this patient by Dr. A. A. Berg at Mt. Sinai Hospital. Through the courtesy of Doctor Berg he was able to report the following findings. In a subtotal resection and Finsterer anastomosis, the stoma was normal. About one and one-half inches distal to the stoma in the efferent loop of dilated jejunum was an ulcer the size of a quarter dollar. The transverse colon was attached to this through a mass of adhesions and a small jejuno-colic fistula was present. The colic fistula was closed and a larger resection including anastomosis and jejunal ulcer was performed. Repair was effected by end-to-end anastomosis of the jejunum and anastomosis to the open end of the stomach.

DR. RICHARD LEWISOHN stated that this case had interested the surgeons at Mt. Sinai Hospital very much, because they had believed with Doctor Santee that he had performed a subtotal gastrectomy. But when Doctor Santee looked up the records, he found that he had done a Finsterer operation. Haberer has demonstrated that recurrences following the Finsterer operation are not infrequent. Doctor LewisoHN stressed the importance of care in nomenclature in reporting these cases, the only operation that could properly be called subtotal gastrectomy was a surgical procedure which removed about two-thirds of the stomach with the pylorus and the diseased part of the duodenum.

A STUDY OF 520 CASES OF FRACTURES OF THE SKULL

DR JOHN A MCCREERY read a paper with the above title, written by himself and Dr Frank B Berry, for which see page 890

DR ALFRED S TAYLOR considered the problem of fractured skulls as essentially one of brain injury, with bone injury entirely incidental. Symptomatology is important chiefly as a guide to treatment. Choosing the correct treatment is often difficult. The cases may be grouped according to type and degree of brain injury, the important corresponding symptoms would follow, after which the principles of treatment could be discussed.

Degree of Brain Injury—Group 1—Intra-cranial, extra-cerebral lesions

- (a) Epidural hæmorrhage (usually from middle meningeal)
- (b) Subdural fluid accumulations, (Naffziger) (cerebro-spinal fluid, clear or blood stained)
- (c) Hæmorrhage from the tentorial venous sinuses, causing basal clot, slowly expanding (often occur without bone injury)

The primary injury may cause loss of consciousness varying in degree and duration but brain injury proper is absent and the essential symptoms are due to compression of the brain, the signs of which develop *pari passu* with increase in the collection of fluid, which may be rapid or slow in the individual case.

The epidural clot and subdural fluid sub-groups usually lie over the convexity of the hemispheres. They cause signs of increased intra-cranial pressure, plus, as a rule, pressure on the motor cortex, causing first irritative (convulsive) and then later paretic phenomena.

The tentorial sub-group causes pressure on the mid-brain and bases of the hemispheres at first, and then, by extension of the clot up on the convexity, may cause symptoms similar to the other two sub-groups. However, these symptoms may not appear for days or weeks after the primary injury, and then develop slowly.

In neither the epidural hæmorrhage nor in the subdural fluid sub-group is there direct communication with the subarachnoid space.

In the tentorial sinus sub-group the hæmorrhage is intrinsically subdural and becomes subarachnoid only if the arachnoid happens also to be torn at the time of injury.

Group 2 includes the cases involving intrinsic damage to the brain substance, contusion and laceration varying in degree and distribution, and therefore causing the very variable symptoms so well-enumerated in the paper. Gross hæmorrhage with localized pressure is not common so that localizing symptoms are less evident. It is in this group that brain damage by contre-coup is frequent.

In many cases the pathology of groups one and two may both be present with corresponding confusion of symptomatology. In both groups, œdema of the brain soon develops causing increased intracranial pressure, far greater as a rule in group two, (because of intrinsic brain damage) than in group one.

FRACTURES OF THE SKULL

Symptomatology—*Group 1* shows more or less primary loss of consciousness, followed by lucidity, and this again by signs of increasing intra-cranial pressure, indicated by motor cortex irritability or paralysis, and deepening coma

Group 2 shows primary loss of consciousness, which is usually more marked and of longer duration than in group one

Focal paralytic symptoms are not so common but there is more disturbance of the mid-brain and stem, as indicated by the marked circulatory, respiratory and pupillary changes. In the severe cases, coma rapidly deepens and death ensues in a few hours. In more fortunate cases lucidity gradually reappears and recovery occurs

Spinal Fluid Tap—Clear in Group 1, sub-group (a)

Clear or blood stained in Group 1, sub-group (b and c)

Bloody in practically all cases in Group 2

Pressure increases *pari passu* with increased intra-cranial pressure

Pupillary Signs—Fixation of one or both pupils means serious injury of the mid-brain. Fixation plus wide dilation of one or both pupils indicates such serious injury that death is practically sure

Fundi—Even in the face of marked increase of intra-cranial pressure as indicated by the spinal manometer, there is usually no evidence of choked disc for at least forty-eight hours, so that fundus examination is not helpful in the very early cases, unless possibly engorgement of the veins might be suggestive. Respiration is likely to be stertorous, but if it develops the Cheyne-Stokes syndrome the outlook is unfavorable

The *pulse* is usually slower than normal. The pressure may gradually increase but has no fixed ratio to the intra-cranial pressure. If the pulse, after a period of retardation, climbs to 100 or more, and especially if there is associated Cheyne-Stokes respiration, it means that the medullary centres are exhausted and death is imminent

Treatment—*Group 1*—Sub-group (a) Operation when the diagnosis is made

Sub-group (b) Operation when the diagnosis is made

Sub-group (c) The symptoms appear late, the clot surrounds the mid-brain, is extensive and there is little prospect of a favorable result from operation, which however might be tried

Group 2—There has been much argument concerning decompressive operations in this group. It is asserted that death has been prevented, and more particularly that post-traumatic sequelæ, headache, vertigo, tinnitus, neurasthenia, etc., are not nearly so frequent. However, the majority of men, dealing frequently with these cases, operate rarely, using instead means devised to give similar relief without operation

Spinal Tap—This gives great relief to pressure and furnishes valuable information

It may and should be repeated frequently enough to relieve the intra-

cranial pressure There is no menace to the medulla such as exists in posterior fossa tumors

Hypertonic Solutions Intravenously—Salt, and magnesium sulphate, have been almost entirely replaced by glucose solution, 25 per cent or even 50 per cent in doses up to 250 c c It must be sterile and made with perfectly freshly distilled water It may be repeated Fluids in general should be limited, or withheld Caffein-sodium-benzoate intravenously causes definite and fairly lasting diminution in intra-cranial pressure

Confinement to bed for at least three and preferably six weeks will eliminate many of the subjective sequelæ

In cases of persistent headache the lumbar air injection advocated by Penfield should be tried One other observation made by Penfield in his experimental animals may compel revision of our attitude toward operation in these cases His observation is that brain, damaged by needle puncture, or by laceration, if left in situ, causes marked adhesions to the dura, which may cause distortion of anatomical relations, or irritation leading to convulsive sequelæ, whereas if the damaged brain material is removed, the above sequelæ do not occur

It may therefore eventually be indicated to operate in cases, especially where motor or nearby cortex is involved, to remove the damaged material to prevent Jacksonian epilepsy from developing

DR JOHN C A GERSTER remarked that it would be important to know what percentage of the patients who survived have been able to resume their work It was a fact that after apparent recovery for a year or two such patients not infrequently underwent change of mentality and disposition and that a large percentage of them did not live more than five or six years

DR FENWICK BECKMAN stated that the conclusions of the author fitted in well with those of his own study on cases of Head Injuries in Children which he had reported recently One of the differences found between fractured skulls in children and in adults is that in the former fracture of the vault so often occurs without brain injury Hæmatomas under the scalp overlying the fracture of the vault are found commonly in children, while in adults they are not so frequently present These hæmatomas are often due to blood seeping out from the skull thereby compressing the brain In the treatment of fracture of the skull with laceration of the brain, Doctor Beekman was in accord with Doctor McCreery, in that decompression does not give decided relief, but spinal puncture does, only to be used, however, when indicated In his series of 331 cases of Head Injury in Children there were thirty-eight deaths, seven died from meningitis, of the remaining thirty-one cases twenty-eight died in the first forty-eight hours, all showing signs of laceration to the brain The highest mortality occurred, therefore, the same as in adults within the first twenty-four hours following the accident Sequelæ were apparently less often found in children than in adults At the end of two years only five per cent of his cases with fractured skull suffered from sequelæ The sequelæ were not often of organic lesions, but those of

FRACTURES OF THE SKULL

emotional upset. There was a large number whose behaviorism had changed completely. Often they were amenable to training and after two years the symptoms frequently disappeared, although there were two or three who had to be sent to reformatory institutions as they could not be looked after at home. After changes in behaviorism, the commonest sequelæ was headache, this cleared up, however, in all but two cases. One had had a compound fracture which was not decompressed.

DR FRANK B. BERRY (by invitation) said that the intravenous use of caffeine, suggested by Doctor Taylor, had not been tried in this series. He was in agreement with Doctor Taylor as to the fundus changes but there had been a small group of cases in which after several days choked disc persisted, and the patient was operated on for this reason. There are many difficulties in obtaining follow-up statistics at Bellevue Hospital. As Doctor McCreery mentioned 50 per cent of the cases have expressed themselves as being perfectly well. The longest follow-up was three to four years but there were very few of these. The speaker did not believe that any of the cases in this series had had repeated lumbar puncture.

DOCTOR MCCREERY in closing the discussion said that the occasional cases of low spinal fluid pressure had been interesting, but unfortunately they had not been accurately measured. In none of them, however, had there been any noticeable amount of bleeding or cerebro-spinal discharge from the ears or nose. In one recent case there had been an initial pressure of 2 mm. This was in a patient with a considerable degree of concussion and the pressure in the course of four or five hours had gone up to 10 mm. It might be that the low pressure was a temporary phase in the early stages of severe concussion.

The possibility of recurring hæmorrhage as a result of sudden lowering of pressure by tapping in the early hours must be considered, but he felt that this was not likely to occur if the fluid was removed slowly and the pressure lowered by gradual stages. In this series they had not felt that bleeding had been increased by careful tapping. Adding to body fluids while there was increased spinal pressure made more difficult the lowering of the latter, but in the occasional case of shock the latter condition had seemed the more urgent and those cases had been treated by the usual anti-shock methods. While marked fundus changes might only appear after forty-eight hours he still felt that considerable early information might be obtained by more regular and frequent examination of the eye grounds.

TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD APRIL 2, 1928

The President, DR ASTLEY P C ASHHURST, in the Chair

CALVIN M SMYTH, JR., M D, Recorder

FRACTURE OF HUMERUS COMPLICATED BY INJURY TO MUSCULO- SPIRAL NERVE

DR JAMES A KELLY presented a man aged nineteen, who was admitted to St Joseph's Hospital, November 30, 1926, suffering from a fracture of the left humerus about the junction of the lower and middle thirds, laceration of the left axilla, extending from the anterior axillary fold through the axilla to the posterior axillary fold, exposing contents of the axilla and particularly the axillary artery and vein. The two latter were completely separated from their surrounding fatty coverings. There was no injury to either vessel. In addition there were several lacerations about the head and face. Under anæsthesia the lacerations of the head and face were thoroughly cleansed and sutured. The axillary wound was sutured. The fracture of the left humerus was reduced and dressed. The patient made an uneventful convalescence from his wounds.

January 3, 1927, he was readmitted on account of musculo-spiral paralysis. Examination on readmission showed the left upper extremity held with the forearm flexed at right angles to the arm. The wrist flexed so that the hand hung at a right angle to the forearm. He was unable to extend the wrist or to supinate the hand. Pressure over the site of the fracture of the humerus caused burning sensation on the dorsum of the thumb and the radial side of the hand. Biceps, triceps and extensor tendons—at wrist—reflexes were absent. There was an area of anæsthesia over the lateral and posterior aspects of the arm. This area extended from the shoulder cap almost to the elbow. No areas of anæsthesia were found in the forearm, over the lateral aspect of the index finger there was an area of anæsthesia which extended about one inch proximal to the metacarpo-phalangeal articulation. He was unable to extend the hand or fingers, and there was very little movement at the elbow.

Neurological examination, January 7, 1927, revealed a typical wrist drop which, with the other findings present, indicated that there had been damage to the median, musculo-spiral and the ulnar nerves.

At operation, January 12, 1927, exposure of the two ends of the lacerated musculo-spiral nerve showed a separation of about one and one-half inches. These ends were bulbous in character. There was solid union at the site of fracture. The two ends of the musculo-spiral nerve were drawn together, the bulbous portion of the ends excised, and the ends of the nerve held together without tension by means of four fine silk mattress sutures. A square flap of fat and fascia was then dissected on three sides from the superficial fat and fascia, and placed about the line of sutures on the nerve, acting as a cuff. The wound was closed without drainage. Primary healing took place and the patient was discharged January 25, 1927. At present the patient is able to play base-ball, basket-ball and other sports.

An examination made March 12, 1928, showed complete function in this

FRACTURE OF HUMERUS

limb with one slight exception, and that is failure to fully extend the thumb. The extensor muscles are not yet as strong as those on the opposite side but they have considerable power. There is no appreciable atrophy of any muscles.

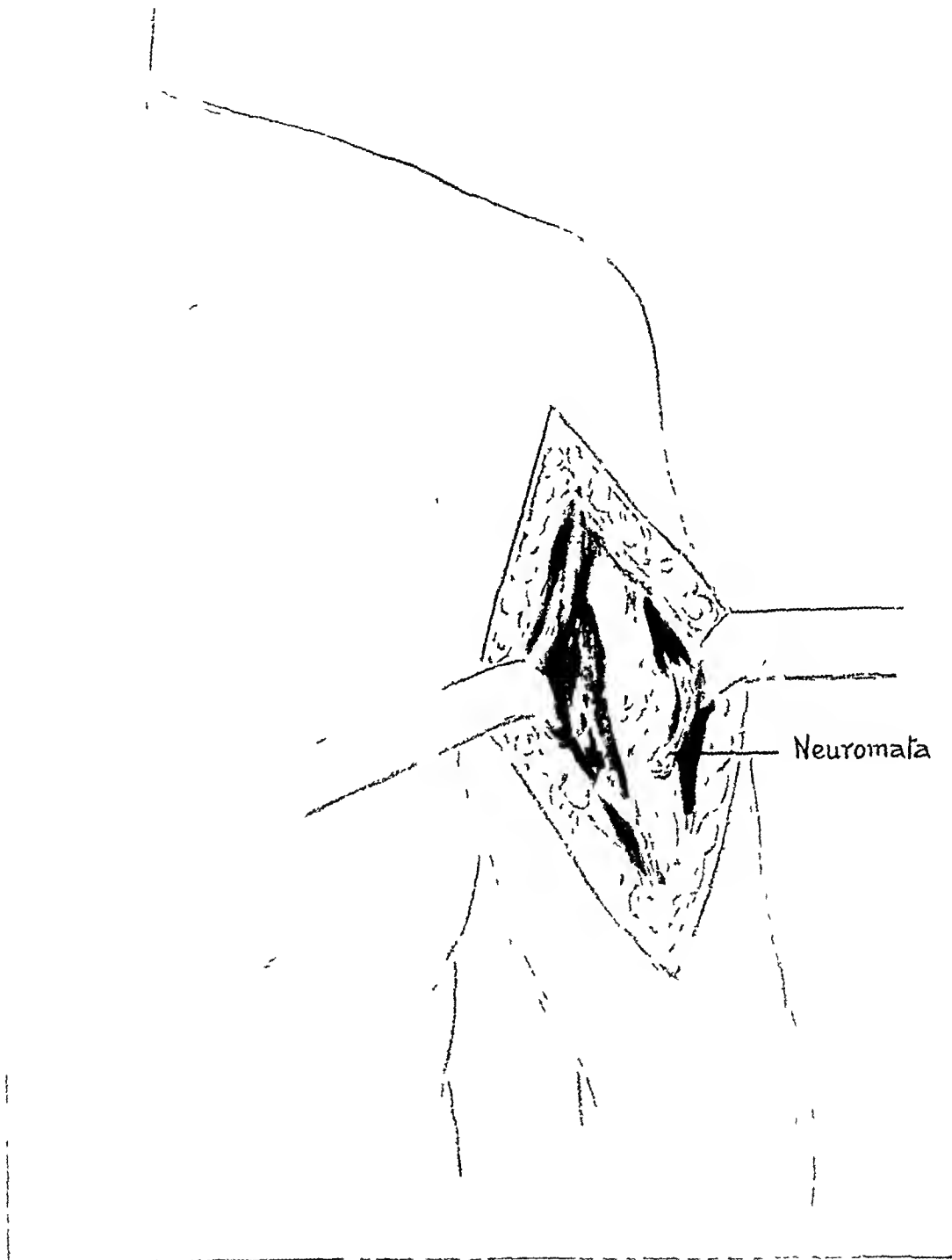


FIG 1.—Condition found at time of operation six weeks after injury, and cut ends of musculo spiral nerve separated about $1\frac{1}{2}$ inches, with bulbous ends.

supplied by the musculo-spiral nerve. The left deltoid muscle is completely atrophied but the supraspinatus has taken over its function, so that the patient is able to extend the limb at right angles to the trunk and about the head. The

biceps and triceps reflexes are normal The electrical reactions are as follows To galvanism in the musculo-spiral distribution the CCC is greater than the ACC, and the size of the contraction is almost normal There is still

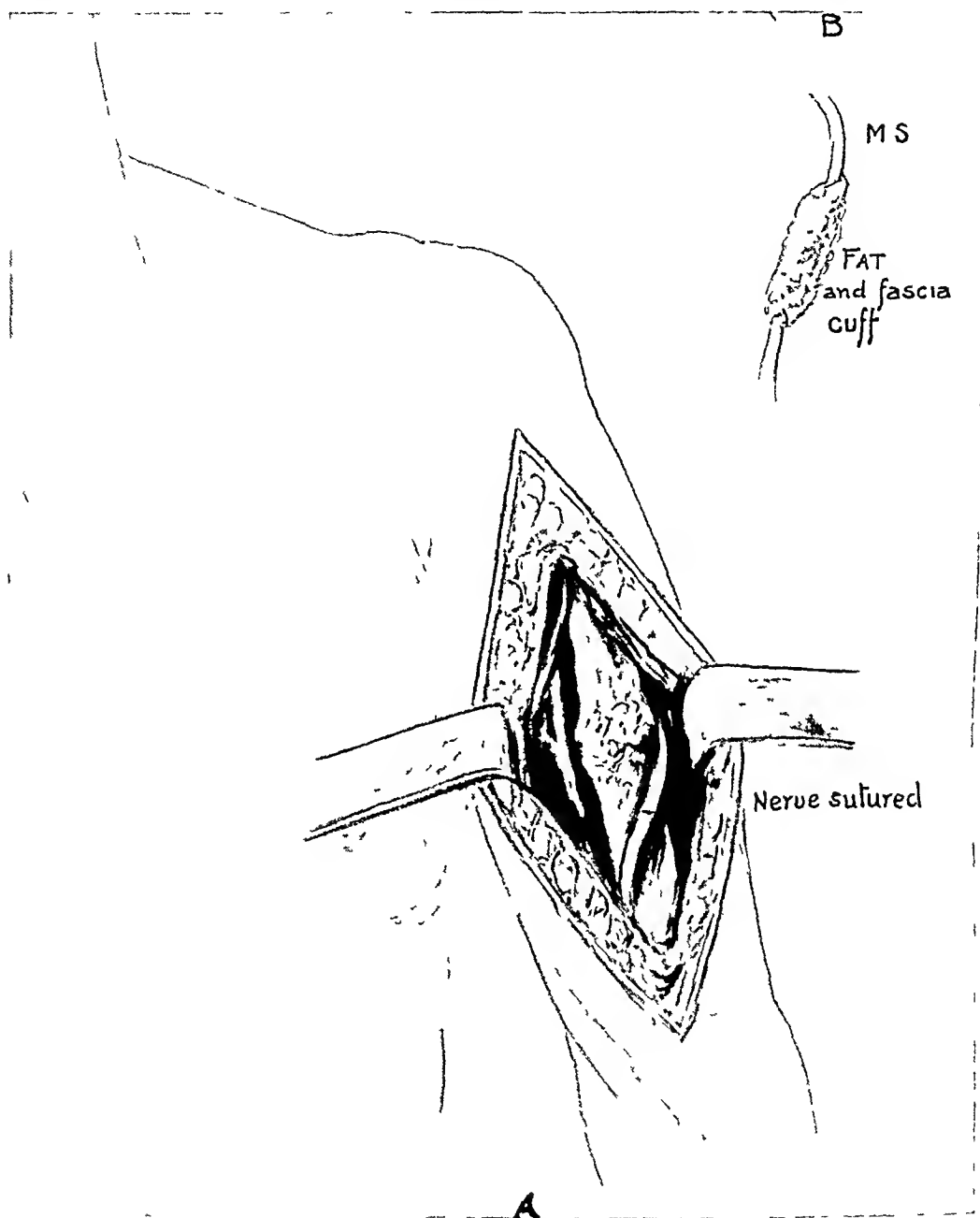


FIG 2—A Shows nerve dissected from callous, bulbous ends resected and nerve sutured
B Sutured nerve surrounded by cuff of fat and fascia

diminished farradic excitability There is no response to either current over the deltoid

There is an area of anæsthesia for light touch and pin-prick over the lower two-thirds of the deltoid and the upper two-thirds of the triceps Deep pressure over the musculo-spiral distribution anywhere causes pain The area of anæsthesia over the deltoid corresponds very well to the distribution of the circumflex nerve The area over the triceps, however, covers the distribution for

CARCINOMA OF THE JEJUNUM

several nerves, namely Part of the area supplied by the external cutaneous and most of that supplied by the internal cutaneous and perhaps that part supplied by the intercosto-humeral

The patient thinks that he began to have return of function eight or nine months after the nerve was sutured Doctor McIver who made the examination stated that he had never seen a case of deltoid-paralysis in which the supraspinatus took on its function

CARCINOMA OF THE JEJUNUM

DR J JAMES CANCELMO, by invitation, reported the case of a woman, aged sixty-three, who was admitted to St Mary's Hospital in the service of Dr James A Kelly, June 21, 1927, complaining of "indigestion" of eight years



FIG 3—The glass rod about 3 mm in diameter extends into the annular constriction due to carcinoma To the left the enormously distended bowel may be seen The portion of gut lying immediately above is the tissue from which the sections (4 and 5) are taken

duration, for the past four years her symptoms have been getting worse Eight months ago she noticed some enlargement of the abdomen which had slowly been increasing Her appetite was poor and about one hour after each meal she had cramp-like pains in the middle of the abdomen She had always

been costive and took purgatives daily Vomiting occurred almost daily The past history is negative except for childhood diseases Examination revealed a distended abdomen with visible peristaltic waves in the lower part of the upper right quadrant No tenderness, no masses palpable The usual examinations of the blood and urine were negative, the blood chemistry and tests of kidney function were within normal limits

Fluoroscopic examination of the gastro-intestinal tract showed that the duodenal cap filled after considerable difficulty, and exhibited a flattening not only of the cap but of the entire pyloric end of the stomach The head of the six-hour meal remained in the small intestine which was tremendously dilated, and showed very active peristalsis Evidence of obstruction was present in the

small intestine at a considerable distance from the pylorus, but the exact nature could not be determined

At operation, by Dr James A Kelly, June 27, 1927, a large mass was exposed, involving about three feet of jejunum The gut was grayish in color and was held together by adhesions In the middle of the mass infiltration was marked Above the indurated area the gut was greatly distended, and below it was collapsed There were very few enlarged nodes, except in the immediate vicinity of the growth A section of the gut, measuring four feet, was removed with its mes-



FIG 4—Sixteen mm objective Normal jejunum Cross and tangent section of villi and crypts of Lieberkuhn

entery An attempt to restore the continuity of the bowel by end-to-end anastomosis was unsuccessful, due to encroachment upon the lumen The anastomosis was therefore made by a simple lateral short circuiting operation The abdomen was closed without drainage The patient was discharged on the eighteenth day after operation, very much improved

Pathological Report—Macroscopic The operative removal is a large mass of adherent loops of jejunum which when separated measure 117.5 cm in length A small firm tumor was present in the centre which when cut out measured 3.7 cm x 2.5 cm x 1.2 cm and was found to be an annular or ring neoplasm, encircling the intestine and constricting the lumen which admitted a 5 mm quill The intestine on the proximal side was dilated times two There were several small polypoid growths of brittle tumor mass extending into the dilated intestine of the proximal side The neoplasm had invaded all the coats of the intestine but none of the other loops were involved (Fig 3)

Microscopic Study of the neoplasm reveals a primary adeno-carcinoma in the mucosa of the jejunum which invades the muscular and serous coats The tendency to form acini with central lumen is lost as the tumor cells penetrate the mucosa and they diffusely infiltrate the muscle in the form of small alveoli consisting of compact masses of cell groups (Figs 4 and 5)

CARCINOMA OF THE JEJUNUM

Pathological Diagnosis Primary adeno-carcinoma of the jejunum

The reporter added that Probstem¹ states that in 41,858 necropsies performed at the Vienna General Hospital, 3,585 were carcinoma, of these 342 were in the intestinal tract and only nine of these were in the jejunum. In the past twenty years, 4,684 cases of gastro-intestinal carcinoma have been operated on at the Mayo Clinic, and thirty-six cases or less than 1 per cent were in the small intestines.² Unless the carcinoma is obstructive the physical findings show very little that enables one to make a diagnosis. The mass is very often not palpated because of the fluidity of the intestinal contents. Auscultation should help more but there is little evidence that his procedure is much used. Unless the lesion is ulcerative blood is not found in the stools so that this test does not help much. Even the X-ray seldom points out the lesion to be carcinoma.

BRICKNER and MILCH² report a case of carcinoma of the ileum in which the symptoms were those of sciatica. Nuzum³ has observed two instances in which the patient's conditions were diagnosed as pellagra and at autopsy, carcinoma of the terminal portion of the ileum was found. Rankin⁴ reports four cases of acute intestinal obstruction due to malignancy, while Morrison¹ reports a case of high intestinal obstruction due to carcinoma.

Prognosis The cases of intestinal carcinoma which have the best outlook are those which are operated upon earliest. Those with obstructive lesions will be seen earlier than others. One is impressed with the fact that the lower the lesion the better the prognosis. In the reporter's case, the lesion was an annular carcinoma. Its removal was not only feasible, but indicated. At the present writing three months after operation, the patient has gained thirty pounds in weight, has regained her strength and has no complaints.

DR DONALD GEIST reported from the service of Dr James A. Kelly, at



FIG 5.—Sixteen mm objective. Primary adeno carcinoma of jejunum. The tendency to form acini is lost as the tumor cells penetrate the mucosa and they diffusely infiltrate the muscle in the form of alveoli.

¹ Probstem, J. G. Subacute Ileocolic Intussusception Secondary to Carcinoma of the Ileum. *Surgery, Gynecology and Obstetrics*, vol. xlii, pp 769-771, June, 1926. Quoted by Morrison. High Intestinal Obstruction Caused by Primary Carcinoma of the Proximal Jejunum. *The American Journal of Surgery*, vol. 11, pp 154-159, February, 1927.

² Brickner, Walter M., and Milch, Henry. Carcinoma of the Terminal Ileum Causing "Sciatica". *International Clinics*, vol. iv, pp 238-239, December, 1926.

³ Nuzum, Franklin R. Pellagra Associated with Annular Carcinoma of the Terminal Portion of the Ileum. *Jour. A. M. A.*, vol. lxxv, pp 1861-1863, December 12, 1925.

⁴ Rankin, Fred W. Acute Intestinal Obstruction Due to Malignancy, vol. xlii, pp 638-641. *Surgery, Gynecology and Obstetrics*, May, 1926.

the Misericordia Hospital, the case of a white woman, age forty-three, who was admitted to hospital, October 9, 1927. Her chief complaint was bloody stools. She stated that two years prior to admission she began to have aching abdominal pain about the umbilicus, radiating from right to left abdomen. Occasionally she noticed small amounts of bright red blood mixed in with the feces. Pain gradually grew worse and in January, 1927, became very severe and was associated with marked diarrhoea and loose, watery stools containing large amounts of bright red blood. This attack lasted for about two months and then subsided, the pain ceasing first and then the blood, the stools very quickly becoming formed. She remained well until the latter part of June and early July when she had a second attack, exactly similar and lasting five weeks. From the end of this attack to the date of admission she remained well and



FIG 6—Polypsis of colon, gross appearance. A portion of the section removed.

free of symptoms. Appetite good and no loss of weight noticed. Only other symptoms were occasional swelling of the feet and ankles, and occasional frequency of urination. Past medical and social history were negative. Family history showed the presence of malignancy in one sister, one brother and father and grandfather but was otherwise negative.

When admitted no definite mass was palpable although there was a suggestion of a soft mass just above and to the right of the umbilicus, suggesting a mass in the transverse colon. Rectal examination

was negative. Blood Wassermann was negative in both the acetone insoluble antigen and the cholesterin antigen. Feces were positive for occult blood.

X-Ray examination of the colon showed an "irregular filling defect in the first part of the transverse colon. This was suggestive of multiple polyposis, possibly associated with ulceration."

Operative Findings—The patient was operated upon by Doctor Kelly, October 15, 1927. Upper right rectus incision. Most of the transverse colon lay below the umbilicus. Its appearance was normal. Palpation revealed numerous, small, soft, pulpy, grape-like masses, apparently springing from the mucosa and slipping from the grasp quickly and easily. The outer coats of the bowel were smooth, pliable and showed no evidence of induration or fixation. There were no adhesions and no masses felt in the mesentery or omentum. The growths began about 100 cm from the splenic flexure and extended for about 25 cm to the left. About 25 cm of the transverse colon were excised with the cautery. An end-to-end anastomosis was done. There resulted good approximation with an opening of over two fingers' breadth diameter. The abdomen was closed without drainage. Diagnosis at operation was diffuse polyposis of the transverse colon.

Progress of Case—Except for occasional vomiting of small amounts of bile-stained fluid and hiccoughs which stopped on the second day after gastric

CARCINOMA OF THE JEJUNUM

lavage, convalescence was uneventful until October 26, when she developed slight tenderness in the right calf and inner thigh, a definite but mild phlebitis. This subsided and on November 4, 1927, she again was well. The first bowel movement occurred on the fourth day after operation and recurred daily for five days. They showed no gross blood. Three examinations of the feces were negative for occult blood. Barium enema the day before her discharge resulted in the report, "Injection of the colon shows an extremely short, ascending colon, measuring 10 cm. There is a very marked incompetency of the ileocaecal valve. At the site of the operation there is a very slight constriction. The remainder of the colon fills normally." The patient was discharged in good condition on November 13, 1927.

The pathological report recorded that the portion of the colon removed was covered with upwards of 300 pedunculated tumors ranging in diameter from three to four millimetres to about one centimetre, round, of a dark red color, a few of the largest showing bleeding points corresponding to superficial ulceration (Fig 6). Some of the smaller tumors have no pedicle. The tumors are soft, the base does not appear to infiltrate the mucosa and no evidence of tumor is seen anywhere else in the deeper structures of the colon. Lymph-nodes of the mesentery are not enlarged. Microscopically (Figs 7 and 8), the polyps are formed of a well developed vascular pedicle, supporting a papilliferous growth formed of connective tissue frame-work with well-formed lymph-nodes. They are covered with cylindrical epithelium often showing mucoid degeneration. Mucus glands are well developed and the epithelium occurs everywhere in a single layer, the cellular elements being normal."

The reporter added that the presence of polypi in the gastro-intestinal tract has frequently been reported.

Statistics as to incidence are varied and scattered and difficulty is experienced in arriving at the true frequency of the lesion.

Two theories as to the origin of polyposis have gained prominence although many factors have been projected as causes. The first of these is that the lesion is congenital in origin. The second theory is that the lesion is an acquired one and the result of chronic irritation and inflammation. Among the many forms of irritation mentioned are chronic gastritis, atrophic gastritis, constipation, dietetic errors, irritation by foreign bodies or parasites such as the ascaris, alcoholism, faulty and incomplete mastication and atheroma of blood-vessels. There may be a certain hereditary influence in cases of gastro-intestinal polyposis, as the lesion has been found in brothers and sisters, twins and in mother and son. Certain observers state, "It is very probable that there are two types of epithelial overgrowth, an hyperplasia secondary to inflammation and an hypertrophy congenital in origin."

A variety of pathological entities have been included in the term polyposis. Polypi are fairly commonly seen in the rectum and there are numerous cases of multiple polypi scattered through the gastro-intestinal system. Myomata, fibromata, adenomata and carcinomatous growths, which assume a polypoid form, are included. Menetrier's pathological classification is still accepted. He divides polyposis into two groups: the first, polyadenoma polypeaux, in which a great many separate and discrete, usually pedunculated or lobulated

nodules involve the mucosa, the second group he calls polyadenoma en nappe in which, there is a raised, plaque-like, non-lobulated, non-pedunculated layer of hypertrophied mucous membrane. The individual polyp appears as soft, warty growths, varying in size from that of a pea to that of a nut or even larger. The color varies from a gray to a red or reddish-brown and the polyp often exude a considerable amount of mucus. They are lobulated or pedunculated and scattered diffusely but closely together along the mucosa. The number varies from a few to several hundred or more. Often they show

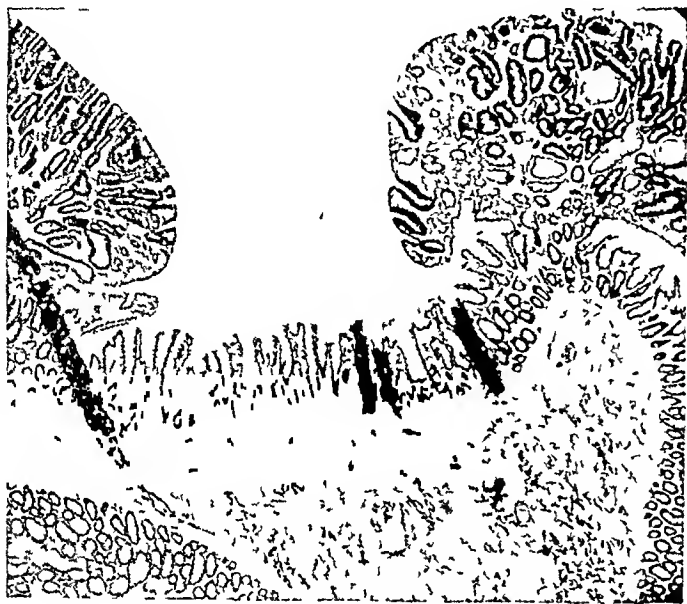


FIG. 7.—Section of polyps of the colon (microscopical)

small hæmorrhages or ulcerations. Frequent inflammatory changes occur. Microscopic examination shows the normal epithelium of that portion of the gut in which they occur and a supporting stalk of connective tissue. The submucosa is well developed and normal and often the muscularis mucosa is well seen. Malignant degeneration frequently occurs and shows itself by the same changes as in other neoplastic growths, namely undifferentiation

of the epithelium, pleomorphism, mitosis and the extension of the epithelium past its normal boundaries. The actual frequency of such changes varies from 12 per cent or 17 per cent to 60 per cent according to different authors. The other common secondary change is inflammation, the result of frequent irritation and trauma.

Polyposis offers no definite symptom complex. The disease may produce the most variable of symptoms or be marked in its involvement and yet devoid of signs. When the stomach is involved the symptoms are often those of any gastric disorder, be it ulcer, carcinoma or gastritis. They are, however, usually of long duration and with little or no constitutional effects. Abdominal pain and distress are frequent. The pain has no reference to meals, time of day, or type of food and may be mild or severe. However, frequent eating of small amounts of food often gives relief. It occurs no matter whether the lesion be in the stomach, small or large intestine. Vomiting, anorexia, constipation and weakness are noted. Hæmatemesis occurs and there is often occult blood in the stools but the acute hæmorrhage is rarely fatal. The picture may be that of a long-standing anemia with its blood findings, a little shortness of breath, pitting œdema of the extremities and weakness. A fairly constant finding, and one reported by many, is the presence of a marked diminution in or absence of

HELIOOTHERAPY IN EXTRA-PULMONARY TUBERCULOSIS

acid in the gastric contents. Due to the latter, diarrhoea may develop. When the growth involves the colon there is marked diarrhoea, tenesmus, hæmorrhage from the bowel and often pus and mucus in the stools. Yet with it all, loss of weight is slight and the general appearance of the patient is that of good health. The blood picture is negative or shows a moderate secondary anemia. Physical examination is usually negative although in some cases a mass may be felt. The latter is soft, freely movable and slips from the grasp easily so that a second effort at palpation makes one believe that there is none. Occasionally the symptoms become those of obstruction or intussusception and the latter is frequent in its occurrence.

The X-ray findings are significant and the diagnosis often made by this means alone. According to the late Doctor Carman, "The roentgenograms show a diffuse mottled appearance of the pars pylorica and the lower pars media without six-hour retention or a correspondingly palpable mass. This mottling is due to the displacement



FIG. 8—Section of polyps of the colon (microscopical)

of the barium by the approximation of the polyps which, offering no resistance to X-ray, produce numerous small, black shadows in the silhouette of the stomach." The same mottled appearance occurs in other parts of the intestinal tract, giving an appearance much like a bunch of grapes.

The treatment of diffuse polyposis is essentially surgical. If the growth is small and fairly well circumscribed, it may be removed by excision. When large and at all spreading, it requires resection. Occasionally such procedures as gastro-enterostomy have been attempted but have failed. The lesion almost always requires complete extirpation.

HELIOOTHERAPY IN EXTRA-PULMONARY TUBERCULOSIS

DR. RICHARD T. ELIASON, by invitation, said that his remarks were based on the work of the past three years in the heliotherapy demonstration at Chestnut Hill. This demonstration was organized to show what results could be

obtained with the use of heliotherapy in the extra-pulmonary forms of tuberculosis in children at this altitude and close to a big city. At the end of this period it is felt that the results have been most gratifying—so much so that the demonstration has been continued.

Of course the ideal location for the use of heliotherapy is one having both altitude and an atmosphere free from the smoke and dust raised by a large

city. It is under such circumstances that the ultra-violet portion of the sun's spectrum is strongest, but the amount that penetrates to the ground in the outskirts of any large city is sufficient to be of great therapeutic value. It is well known that it is the ultra-violet band of sunlight that has the greatest therapeutic value but there is a growing feeling that the visible and infra-red regions also are of value and tend to augment the effects of the ultraviolet. Heliotherapy is really much more than just the use of the ultraviolet radiation derived from the sun and should include fresh air baths, rest, diet and a strict adherence to all well established conservative orthopaedic practices. Spring and early summer are the best



FIG 9—Result of heliotherapy in extra pulmonary tuberculosis

times for heliotherapy for then the ultraviolet portion is strongest. Also the air temperature is such that the middle of the day can be used. In the summer the heat of the day should be avoided and the morning and afternoon hours used. Fresh air baths are an important factor and are responsible in large part for the marked muscular development, and the excellent state of general nutrition that these children show. All children and especially those that are emaciated or are acutely sick must be acclimatized gradually to the fresh air before they are exposed to the sun. Diet needs no special comment except to insist that it be plain, of sufficient amount and contain the necessary building materials. Rest is second only to the ultraviolet in importance and in some cases even more important because if the diseased part is not put

HELIOOTHERAPY IN EXTRA-PULMONARY TUBERCULOSIS

at rest no amount of ultraviolet will bring about cure. During the acute stage, especially in bone and joint involvement, absolute rest of the part is essential, and this rest must be continued until there is X-ray evidence that there has been healing of the diseased area. Even then an additional four to six months will reduce the number of recurrences. After the subsidence of the acute stage gradual increase in motion can be allowed as it prevents ankylosis but weight bearing should not be allowed for several years. The last factor in heliotherapy is an adherence to accepted orthopaedic teaching in all respects except one. We must continue rest in the strict orthopaedic sense and we must continue the usual methods for the prevention and correction of deformity, but heliotherapy has introduced one marked departure from the usual teaching. We have been taught that ankylosis, as firm and enduring as possible, is to be sought in all cases involving joints but the introduction of heliotherapy has shown that healing can take place without



FIG. 10.—Result of heliotherapy in extra-pulmonary tuberculosis

ankylosis and that a surprising amount of motion can be returned to many of these joints. This, in the speaker's opinion, is the most important change that the use of heliotherapy has brought about. For ultraviolet is not a specific cure for any type of tuberculosis but only puts the patient in the best possible condition to combat the disease with the means that he has within himself.

Just what are the benefits that can be expected from the use of heliotherapy in this type of tuberculosis? First the general results are an enrichment of the blood both in its hæmoglobin and cellular contents, a better appetite and a better digestion, an increase in metabolism, resulting in an increase in general nutrition and the development of a firm musculature and also a change in the mental attitude that in many children is truly remarkable. All these results are well illustrated by the pictures of Case 1 and the general pictures of Case 2.

The local effect on ulcers, sinuses and open wounds is well seen in the pictures of the local lesion in Case 2. Sinuses at first have a more profuse and

thinner discharge but soon tend to heal. Ulcers show healthy granulation tissue and a marked tendency to epithelialize. There is also a marked tendency to calcification of rarified bone as can be seen in Case 3. There is also a

marked tendency to an increased rate of absorption of fluid from the peritoneal and pleural cavities.

The amount of function that can be restored to a seemingly hopelessly involved joint is well shown by Case 4.

These results are not limited to cases with tuberculosis but can be duplicated and even excelled in non-tuberculous conditions. Equally favorable



FIG 11—Site of disease at elbow, showing limitation of motion, when treatment was begun

results can be obtained in adults. DOCTOR ELIASON thinks that a more extensive use of heliotherapy by surgeons in general would lead to very gratifying results and would amply reward any effort necessary.

DR HUBLEY R OWEN recalled that three years ago, Dr A Bruce Gill showed a series of cases before the Academy, which had been treated by this method in Atlantic City. Two years ago the speaker had visited Rollier's colony and was impressed with the remarkable muscular development in the patients which he saw. There was also a striking absence of wasting and anemia in practically all cases. Doctor Owen said that very little surgery of any sort was done on these pa-



FIG 12—Same case as shown in Figure 11, after two years' treatment

tients, for example, tuberculous empyema is never operated upon or even aspirated. Cases of Pott's disease are treated without plaster cases or fixation of any sort.

DR WALTER G ELMER said that the chief difficulty is lack of facilities for carrying out the treatment. In the Orthopædic Department of the Philadelphia General Hospital, and also in that of the Graduate Hospital of the Uni-

versity of Pennsylvania, the Social Service Departments have great difficulty in placing patients in sanitariums in the country where they can receive the open-air sunlight treatment. Quite a number of them are sent to the Children's Seashore House in Atlantic City, where about 500 can be cared for



FIG 13—Tuberculosis of ankle, condition when treatment was begun



FIG 14—Same case as shown in Figure 13, after one year of treatment

during the summer months—not so many in winter—and occasionally a child was admitted to the Chestnut Hill Sanitarium. If there were five times as many beds available in this latter institution, as there are at present, it could be kept filled throughout the year. It is exceedingly difficult to find a place for a patient over thirteen years of age.

There is no way of treating these patients that can compare with the open-air sunlight method

DR RUTHERFORD L JOHN said that Doctor Rollier does not use the lamps but depends on the sunlight entirely. Here one does not have the sunlight as constantly and so the lamp is of great help. The work which Rollier has done is magnificent, especially in the treatment of tuberculous disease of bones. The older idea that one should be content with arrest of the disease and permanent fixation of tuberculous joints, no longer obtains. Many cases treated by heliotherapy recover without loss of motion in the involved joint.

DR RICHARD T ELIASON (closing the discussion) said that he has not resorted to surgery in any of these cases. Some of the cases have had surgical treatment prior to their arrival at the institution, but it has not been found necessary to send any of them back for surgery. The sinuses have healed themselves fairly well except those of long standing, *i e*, over five or six years. Where the underlying lesion is a secondary infection, the sinuses are permanent although the amount of discharge is greatly reduced.

As to the lights, the initial cost of the carbon lamps is less than the mercury quartz lamp. There are other types of carbon arc lamps in use, one at the Taft Hospital in Cincinnati is designed for large groups of patients and consists of four large carbon arc lamps suspended from a central pivot. The patients are grouped around the light, the footboards taken off the beds, and the patients are so arranged that the light is cast on them perpendicularly, which tends to greater absorption. As to the comparative value of the carbon vs the mercury lamps in the treatment of this type of lesion, the carbon arc lamp is considered to be the better for extrapulmonary lesions. The advantage of the mercury lamp is that with it one can give more ultraviolet rays in less time and this is of help in office work where one does not wish to clutter up his office by taking several hours to the one patient. In a number of clinics, especially in Germany, they use mercury lamps reinforced with lamps giving visible light and heat as they believe this to be of value. Gauvain has stressed the value of fresh air as being responsible for the development of the musculature and the subcutaneous fat. He shows that in his treatment of patients at the seashore where children who are unable to walk are carried out into the water the estimation of the metabolic rate before and after shows an increase of about 1000 per cent. He thinks that it is the "kick" which is gotten from the hydrotherapy which is responsible for the body musculature. Fresh air is really half of the game. The ordinary treatment rooms for heliotherapy apparatus are generally very badly ventilated and much of the benefit is thereby lost. Rollier starts his patients with fresh air baths, even before putting them in the sun. This is practiced at Chestnut Hill, the children's garments are taken away from them one by one until they end up in the G-string. With bed patients the amount of bed clothing is reduced until the patient is entirely exposed and they are then put in the sunlight.

SUPPURATIVE PERICARDITIS

DR EMORY G ALEXANDER pronounced the annual oration entitled "Suppurative Pericarditis from the Surgical Viewpoint", for which see p 801

BRIEF COMMUNICATIONS

CONGENITAL VENOUS CYST OF THE MEDIASTINUM

A CONGENITAL venous cyst of the mediastinum, so large as to produce serious obstruction to respiration and to venous return through the innominate

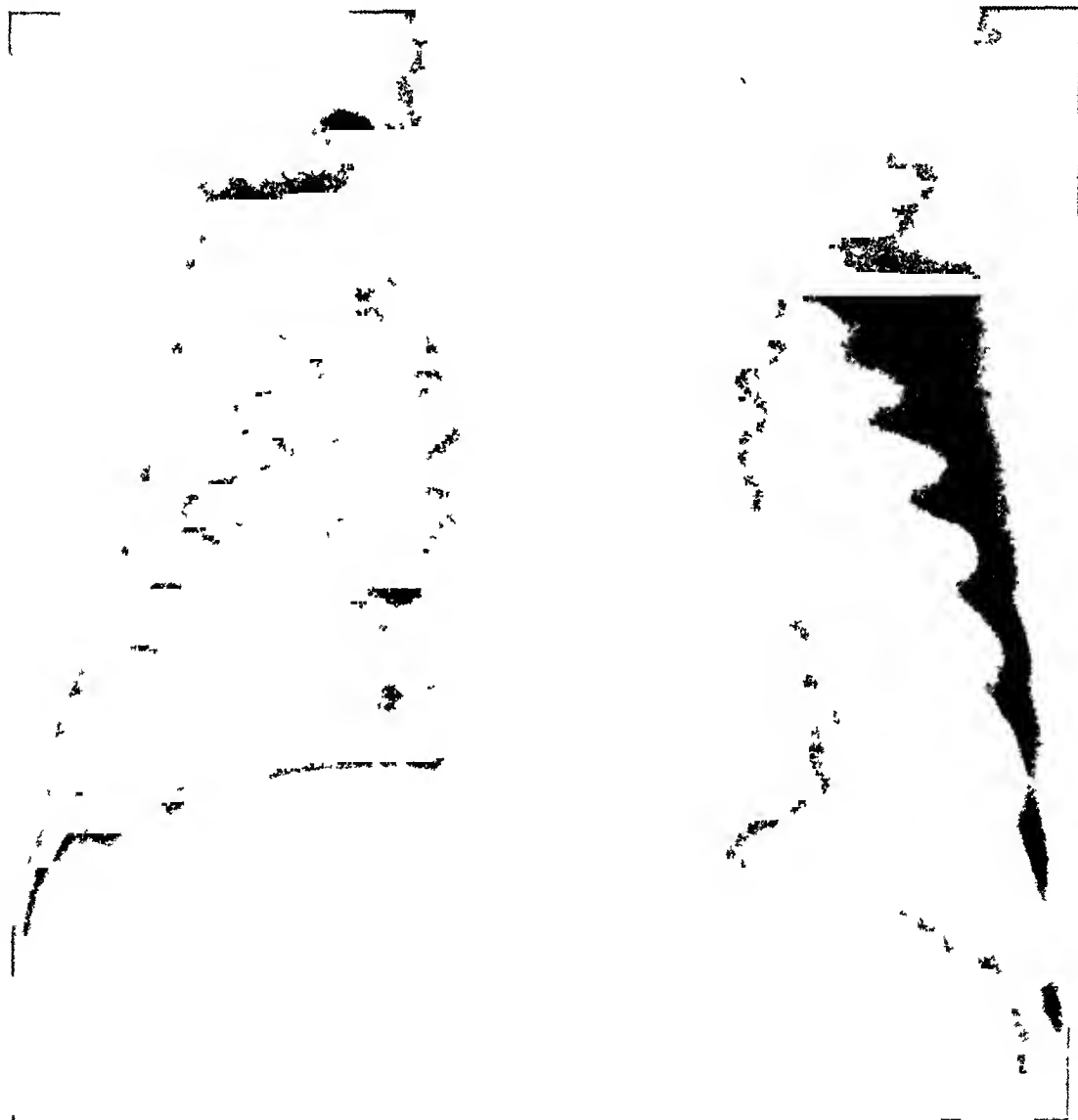


FIG 1—Skirgram of the infant's chest at the time it was first seen. Note the enormous widening of the mediastinal shadow which was misinterpreted as being due to a greatly enlarged thymus. X-ray treatment did not reduce the size of this shadow or cause the disappearance of her symptoms.

nate veins, is sufficiently unusual to warrant its being recorded. I have been unable to find a report of a similar case.

A female infant, five months old, was brought to the Out-Patient Department of the Hospital for Sick Children with the complaint that for four weeks she had suffered from (1) a swelling on the right side of the neck, (2) a peculiar spasmodic cough, (3) a hoarse cry, and (4) attacks of cyanosis.

BRIEF COMMUNICATIONS

Examination revealed a normal baby except for the swelling in the neck and its associated signs. Beneath the lower end of the right sternomastoid was a rounded swelling approximately the size of an egg. The size of the mass was not constant, however, but varied with respiration. On forced expiration, as in crying, it became much larger, and during inspiration it diminished greatly. The walls were soft and thin. Fluctuation was readily elicited. The mass had not the firm induration of an inflammatory mass nor the resistance of a branchial cyst. There was no corresponding mass on the opposite side. Redness, tenderness or other evidences of inflammation were not present. The temperature was normal and the throat was not inflamed. No enlarged

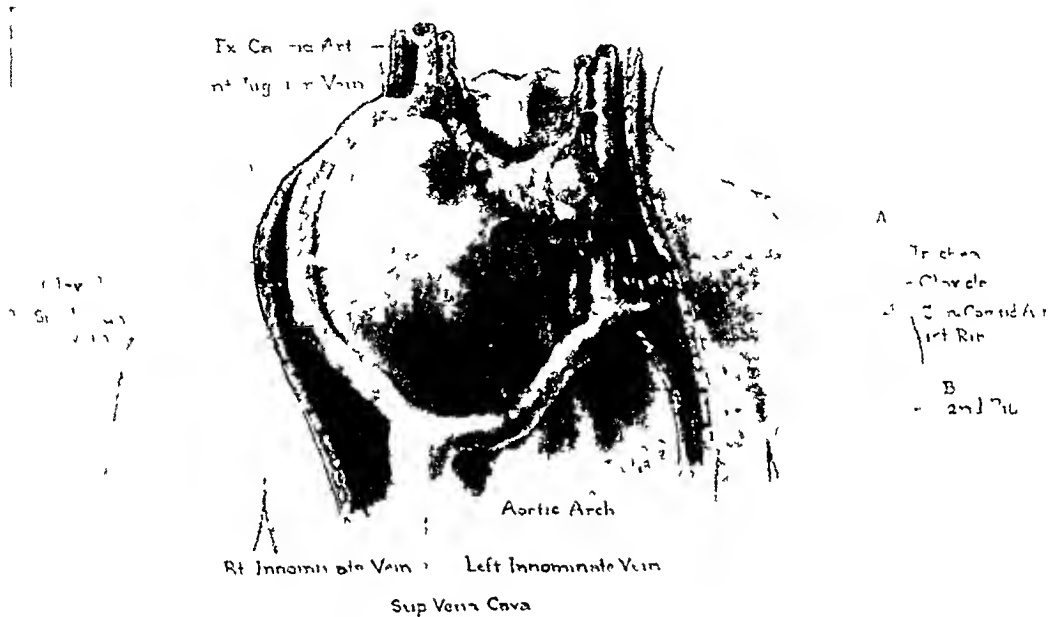


FIG. 2.—Drawing of the cyst and its relations, reconstructed from operative and post mortem findings. A, B, C and D represent the venous radicles by which the cyst communicated with the surrounding veins. It was rupture of the radicle "A" which permitted collapse of the cyst.

cervical glands could be felt on either side. The infant's cry was peculiarly hoarse, and from time to time a spasmodic cough distressed the child. The face was constantly cyanosed and this cyanosis was noticeably increased when the child cried.

The tumor felt like a greatly enlarged jugular vein, but a diagnosis between this and a cystic tumor lying upon the jugular vein and pushed into greater prominence when the vein was distended was not possible. In an effort to reach a diagnosis the tumor was aspirated. Pure venous blood was obtained, which proved sterile on culture. This appeared to confirm the diagnosis of dilated jugular vein. Such venous enlargement and the cyanosis pointed to some obstruction to venous return. In this connection, an enlarged thymus was thought of as a possibility. X-ray of the chest (Fig. 1) revealed an enormous mediastinal shadow in the region of the thymus, which was interpreted as a greatly enlarged thymus pressing upon the right innominate vein and causing the peculiar symptoms. The unilateral distribution of the signs could not be interpreted.

The child was treated for enlargement of the thymus by an adequate dose of X-ray. At the end of six weeks its condition was much worse, and X-ray showed no diminution in the size of the shadow. It then became evident that the shadow seen in X-ray could not be that of an enlarged thymus. The physical findings were much changed. Embarrassment of respiration was now extreme and cyanosis was constantly present. The tumor now projected above the clavicle and behind the sternomastoid instead of lying under the latter. It no longer fluctuated but gave the impression of being a solid rounded tumor about the size of an egg. It underwent the most extreme excursion

CONGENITAL VENOUS CYST OF THE MEDIASTINUM

during respiration. During inspiration it completely disappeared behind the clavicle, during expiration it rose forcibly from behind the clavicle and projected into the neck. The range of this movement during forced respiration was four inches.

It was now felt that the mass was a solid mediastinal tumor, probably a sarcoma, and operation was deemed justifiable.

Under ethyl chloride and ether anæsthesia, the mass was exposed by means of a transverse incision across the right sternomastoid one inch above the clavicle. It proved to be an ovoid tumor about the size of a lemon, extending from the position it occupied in the neck downwards into the mediastinum. It had firm and clearly defined walls which were not adherent to the surrounding structures. It moved freely with respiration up and down in the mediastinum. It appeared at first to be solid, but in separating it from the thyroid a venous radicle was torn across, resulting in a gush of venous blood and the collapse of the tumor. It was then evident that it was a venous cyst. After collapse of the cyst no further hæmorrhage occurred, indicating that such venous communications as must have been present at one time were now obliterated. The mass was separated from the surrounding structures and removed. During the latter part of the long operation, the pulse and respiration failed rapidly and in spite of transfusion of blood and the administration of adrenalin, the patient died just as the operation was completed.

A post-mortem examination was performed. Data obtained from this and from the operation permit the following description. The mass was a venous cyst as large as a lemon. Its relations are represented in Fig. 2. It lay behind the right sternomastoid, right clavicle, right first rib and sternum. The trachea was covered by the mass and compressed by it. This accounted for the difficulty in respiration. The tumor filled the notch between the two innominate veins. It received two large radicles, one from the right jugular vein and one from the left innominate vein, and several smaller radicles from the inferior thyroid group of veins. The thyroid lay at the upper pole of the mass. There was no communication with the arteries.

Microscopic examination of the cyst wall showed it to consist of œdematous connective tissue containing a few muscle fibres. An intact endothelium lining was not present but here and there a few scattered endothelial cells were to be seen. The interior of the cyst was for the most part smooth. There were, however, a few sacculations, and here and there the crevices and slight irregularities were filled with thrombotic deposit which was undergoing organization.

COMMENT

I am unable definitely to classify this tumor. The possible conditions which might have given rise to it are (1) an organizing hæmatoma, (2) a cavernous hæmangioma, and (3) a congenital abnormality of the veins. The first suggestion seems hardly to be a possibility. There was no history and no



Venous Cyst

FIG. 3.—The appearance of the pathological specimen.

evidence of injury sufficiently severe to have caused such a hæmatoma. The mass was clearly defined and firm walled, and at one time it communicated with the surrounding veins by large venous channels—facts which seem incompatible with a hæmatoma. The second suggestion may be a possibility, but if this was a cavernous hæmangioma the single cyst was of enormous size and the distinction between such a cyst and a congenitally abnormal vein is ill defined. I am inclined to regard it as a venous cyst of congenital origin due to an abnormal arrangement of the primitive cardinal veins and their branches. While this appears to me to be the most likely possibility it must be admitted that such an opinion does not explain all the clinical facts. At no time during the usual course of embryonic development does there exist a venous communication between the left innominate and right internal jugular veins. If it arose from an embryonic vein it must, therefore, have been derived from an abnormally placed one. Even though such a vein were present it would be more reasonable to expect it to persist as an abnormally placed vein than to expect it to become transformed into a steadily expanding venous cyst. I have submitted the data of the case to Prof. J. P. McMurrich, of the department of anatomy of the University of Toronto, who has kindly examined them for me. He was not able to suggest any embryonic structure of which it might be a development.

There are features other than its origin which are equally puzzling. Symptoms of venous and respiratory obstruction did not occur until the last ten weeks of the child's life, and during this period the evidences of obstructions steadily increased in intensity. This would indicate that the mass was at first small and later increased in size. Moreover, when first seen the cyst communicated freely with the great veins, as indicated by its collapse during inspiration and the failure of aspiration to diminish its size. Its apparent solid nature six weeks later, and the lack of bleeding after the cyst had been opened indicated that the free venous communication had been obliterated. I am inclined to the opinion that the X-ray treatment had something to do with this alteration in its nature.

R. I. HARRIS, M.B.,

From the Hospital for Sick Children of Toronto, Canada

THE APPENDIX AS A PROVISIONAL ORGAN

THE appendix has hitherto been regarded as the vestigial remnant of former development, and in consequence thereof students have been trained to fall upon and destroy it without mercy whenever it could be approached. Some recent experiences of mine have caused me to pause and speculate concerning its history and purpose, and I am constrained now to regard it as a *provisional rectum*, to be so used in emergencies that render drainage and relaxation of the large bowel a matter of extreme importance. Its location can be seen at a glance to be strategic, allowing access to both the large and the small bowel and communicating with the portion of the large bowel in which the contents are still liquid. To reach the cæcum from the

APPENDIX AS A PROVISIONAL ORGAN

rectum a distance of five or six feet must be traversed over a difficult and tortuous route, against obstacles and through much pain to the patient, while to reach it through the provisional rectum, a term which I am pleased to apply to the appendix, requires only the thickness of the abdominal wall, probably two to four inches, and that over a straight and direct, unobstructed, uncomplicated pathway

I am fully aware that what is known as appendicostomy has for many years been employed for treatment of ulceration and other affections of the colon. In other words the purpose has been to achieve the introduction of medication for local therapeutic contact with the bowel. If we judge by the rarity of the application of this procedure, its usefulness must be in grave doubt, while the aims I have sought to make the organ serve are locally to drain and constitutionally to obtain absorption of fluids and nourishment.

The cases in which I have used this method are fifteen in number, and represent the types of abdominal cases that after the operation become afflicted with ileus, distention, peritonitis and death. One case more illustrative than the others consisted in an old abscess of the right tube which made it necessary to resect the bowel in the presence of pus and the peril of general peritonitis. Another representative case of the group was a perforated gastroduodenal ulcer with a hole as large as a lead pencil and the abdomen filled with gastric and duodenal contents. Also, one case of delayed operation for obstruction that looked hopeless. The method employed is to cut and tie the meso appendix, which gives the appendix extensive freedom. The appendix is then pulled through the lower angle of the operative incision, bringing the cæcum against the parietal peritoneum. A sterile safety pin impales its mesenteric border which prevents its slipping back. The end is clipped off and a catheter of a size that will fit snugly is passed through its lumen well into the bowel. The incision is closed in the usual manner and the end of the catheter is left outside the dressing.

You will be greatly astonished at the number of perplexities this simple device will relieve. The large bowel can be readily drained both of gas and feces.

The whole of the large intestine can be filled with water or salines for its gradual absorption. Solution of Epsoms salts can be given in whatever quantity desired. Castor oil or any medicine that is indicated, all without fear of rejection, but with assurance of therapeutic result.

In about six days the appendix sloughs and the catheter can be removed if it has served its purpose. It can be allowed to remain as long as there seems to be any need for it. As soon as the catheter is removed the opening closes promptly. There never has been any hint of a fecal fistula resulting. Fourteen of the fifteen patients I have used it on so far have recovered.

GEORGE A. HENDON, M.D.
Louisville, Ky

BOOK REVIEWS

OPERATIVE SURGERY By J SHELTON HORSLEY, M D Third edition
Large Octavo, Cloth, 893 Pages St Louis, Mo , C V Mosby Co

This admirable book of Horsley's was reviewed in the ANNALS OF SURGERY of August, 1924 It was then a book of 721 pages In the years that have followed it has now reached its third edition and has grown to a book of 893 pages

Its special merit and peculiarity rests in the fact that it describes the author's own experiences There is no attempt made to describe all surgical operations The work, while not complete, is comprehensive The outstanding feature of the work is the emphasis placed upon the physiologic functions and the interpretation of the biological processes that follow surgical operations It is a book more to be applied by one who has already arrived at some surgical experience than one to be used by a medical undergraduate For the philosophical surgeon as well as for the practical operator this book will be accepted for frequent consultation

LEWIS S PILCHER

THE DUODENUM By PROF PIERRE DUVAL, M D , JEAN CHARLES ROUX, M D , and HENRI BECIERE, M D Pages 205 Octavo C V Mosby Co , St Louis, 1928

Of late years much deserved attention has been directed to the question of the pathology, symptomatology and treatment of diseased conditions of the duodenum other than simple ulcer The symptom complex presented in many instances is rather suggestive There has, however, not been any concerted publication relative to the various conditions causing these symptoms until the present one which emanates from France, and is a compilation of the observations of a physician, a surgeon and a radiologist with collaboration of a chemist It has been translated by E P Quain and represents an intimate fusion of the data acquired by each, submitted to each other for mutual criticism, and accepted by all

To many physicians who have been puzzled by unsuccessful treatment of cases of so-called dyspepsia, biliousness and that array of indefinite symptoms which have apparently baffled proper interpretation of the causative factor, the present treatise may serve to clear up many points In fact, some cases of neurasthenia would appear to be due to this class of digestive trouble and may be found to be amenable to surgical treatment A good

BOOK REVIEWS

deal of our present knowledge of duodenal pathology, particularly relating to obstructions, has been gained from the writings of one of the authors, Professor Duval, and we are very pleased to see that these observations have been collected and correlated with those of others in this present volume. This work consists of six chapters taking into consideration the relation of the duodenum in calculous cholecystitis, essential and stenosing periduodenitis, compression of the duodenum by the mesenteric pedicle, duodeno-jejunostomy, the question of duodenal ulcer and a most important chapter on the picture presented by intoxication due to duodenal retention.

Thus, not only to the clinician but also to the surgeon, the book is recommended as suggestive of many problems which its perusal will serve in some measure at least to elucidate.

DISEASES OF THE GALL-BLADDER AND BILE DUCTS. By E. A. GRAHAM, M.D., W. H. COLE, M.D., G. H. COPPER, M.D., and S. MOORE, M.D., Octavo, cloth, pages 456. Lea and Febiger, Philadelphia, 1928.

It is interesting to realize that notwithstanding the enormous number of articles published bearing on this subject during the past decade, and an increasing realization of the importance of this viscus and its diseases, there has been no comprehensive discussion of this subject since 1905, when Rolleston's treatise appeared.

A most careful consideration is therefore most timely when one appreciates that the authors are able to state that from 20 to 25 per cent of all adults have gall-stones and probably an equal number have cholecystitis without stones, concluding therefore that approximately 40 per cent of our adult population have disorders of their biliary tract.

In the present work, while the authors have endeavored to present the subject in a systematic way, particular emphasis has been made of the more newly discovered knowledge of the gall-bladder, especially in regard to its physiology and the diagnosis of its disorders by new methods.

Cholecystography has been presented in detail by the authors having a paternal interest in its development, and shows that much of the criticism against its employment has really been due to a failure to understand its underlying principles, to inaccuracy of interpretation and to poor technic both in the administration of the substances and in the taking of the Röntgen-ray films.

Another most interesting and important discussion is that relative to the application of the various tests for hepatic function and its relation

BOOK REVIEWS

to the diagnosis of biliary disease. The technic of the van den Bergh and the authors' test is given in detail, as are several others.

The surgical aspects of the treatment have been extensively and adequately presented to the exclusion practically of the question of medical care, as the authors feel that the latter is inefficient, except as it is used symptomatically and as a means of preparing patients for operation.

The work is profusely and well illustrated. The radiographic films are particularly informative and well produced.

JAMES T. PILCHER

EDITORIAL ADDRESS

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ANNALS of SURGERY

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ANTI-STAPHYLOCOCCIC EFFECTS OF THE INTRAARTERIAL
INJECTION OF CERTAIN DYES *REPORT OF INTRAARTERIAL INJECTIONS OF MERCUROCHROME 220-SOLUBLE,
GENTIAN VIOLET, AND ACRIFLAVINE IN THE TREATMENT OF EXPERI-
MENTAL STAPHYLOCOCCIC INFECTIONS IN DOGS

By ZUNG DAU ZAU, M D

OF PEKING, CHINA

AND

FRANK L MELENEY, M D

OF NEW YORK, N Y

IN RECENT years intravenous dye therapy has been used in various clinics as a means to combat bacterial infections. Young and his co-workers^{1, 2, 3} have been the chief advocates of this form of treatment. Redewill, Potter and Garrison⁴ have treated large numbers of cases of gonorrhœal urethritis and its complications with gratifying results. Allen⁵ has satisfied himself of its efficacy. Scores of favorable reports have appeared in the literature. To bring forward the accumulated evidence with regard to the effectiveness of this form of treatment, Young³ in 1926 compiled 680 cases which had been treated with intravenous injections of dye. They comprised not only general infections, but also a large number of local lesions. Churchman,⁶ who has brought to light many facts with regard to the antiseptic action of gentian violet, has summed up the matter of dye therapy in a very conservative paper and concludes that the intravenous use of these dyes has, in many cases, an action which is definitely beneficial to the patient although its exact *modus operandi* is not yet understood. The dyes that have been most commonly employed are mercurochrome 220-soluble, gentian violet and acriflavine. The favorable reports have been, for the most part, clinical rather than experimental, although Walker and Sweeney,⁷ Sanner and Hill,⁸ and others have obtained experimental results which would seem to favor the rationale of dye therapy. On the other hand the results have not been regularly satisfactory. It is quite likely that many of the unfavorable results have never been reported—first, because of a natural reticence about reporting failures, and second, because a series of failures is always small and the method is not continued. And yet unfavorable reports have come both from clinics and from laboratories. Thibault⁹ warned against too sanguine hopes from intravenous dye therapy. Tenney and Lintz¹⁰ obtained negative results with acriflavine. Horsley's¹¹ results were not convincing. Simmons¹² could not be sure of any beneficial action with acriviolet or mercurochrome. Meyer, Sommer and Eddie¹³ concluded that mercurochrome failed utterly as a biliary antiseptic, as had been

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claimed Colebrook and Hare¹⁴ found no evidence of bactericidal action in the blood of animals injected with mercurochrome Walker¹⁵ demonstrated that mercurochrome except in high concentration was not antiseptic in the presence of fresh defibrinated blood Martin¹⁶ questioned the whole rationale of dye therapy as then in vogue (1925) St George¹⁷ decried the use of mercurochrome on the basis of autopsy findings in treated cases In general it may be stated that those who have reported failures have concluded either that the treatment was ineffective or that it was directly harmful and hastened rather than prevented death To reconcile the reports of failure with the reports of successful results, several theoretical reasons have been offered

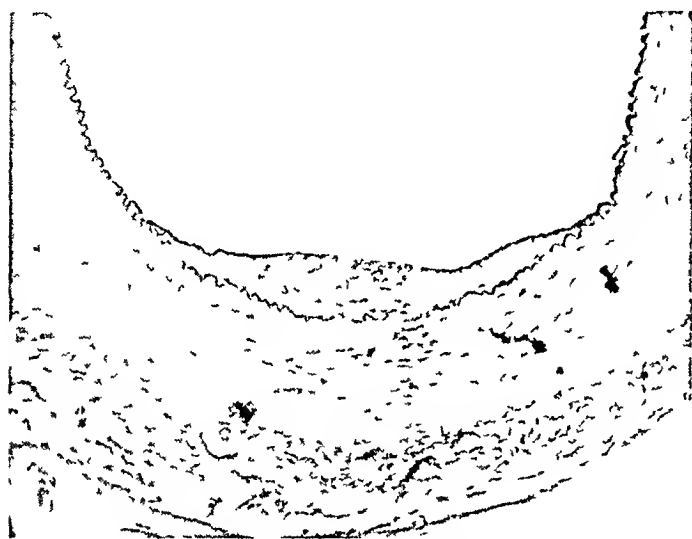


FIG 1—Dog No 9119 Effect of needle puncture on femoral artery one month after the injection of dye It shows a thickened intima and a slightly broken internal elastic membrane This represented the greatest degree of injury found

Burke and Newton¹⁸ and others believe that some failures are due to improper preparation of the dye solutions Thibault⁹ advances the theory, without experimental evidence, that the selective affinity of certain tissues both for dyes and bacteria is of prime importance Many others maintain that these drugs are so much diluted following intravenous injection that bactericidal action is impossible This was our own conclusion

after our investigation of acriflavine¹⁹ We found, further, that a certain amount of the dye, injected intravenously, was quickly removed from the blood, held in the tissues and thus made unavailable as a bactericidal agent either in the blood or in the affected part When a sufficiently large dose was given to render the blood bacteriostatic, destructive changes in such vital organs as the liver and kidneys became evident and resulted in the death of the animal

Certain dyes have unquestionable bactericidal and bacteriostatic action on certain organisms *in vitro* and it seems rational to use these *in vivo* if they do not injure the body tissues unduly and if they can be made to reach the focus of infection in antiseptic concentration Believing that most of the dyes in use are toxic if given intravenously in antiseptic concentration, it seemed reasonable to try to deliver the dyes through the arterial system directly to the lesion We thought that under such circumstances a large part of the dye might be held at the focus of infection and only a small quantity be distributed about the body and held in vital tissues as is the case with intravenous injections This report will demonstrate that our theory was incorrect

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EXPERIMENTAL

Preliminary to the study of the effect of the dyes injected intraarterially on an infectious lesion, a series of experiments was done to determine the effect of the dyes on the animal as a whole when injected in that manner and the local effect of the needle and dye on the artery itself

Throughout our experiments we have used mercurochrome 220-soluble supplied by Hynson, Westcott and Dunning, of Baltimore, gentian violet from Coleman & Bell, of Norwood, Ohio, and acriflavine "pro injections" supplied by the National Aniline and Chemical Company, Inc., of New



FIG 2A—Dog No 8836 nineteen days after the injection of 5 mg of mercurochrome per kilogram of body weight Diffuse degeneration of liver

York All of these dyes were designed for intravenous use They were prepared in 1 per cent and one-tenth per cent concentrations and were used while fresh, one or two hours after preparation Three per cent sodium bicarbonate or buffered distilled water, as suggested by Burke and Newton,¹⁸ were used as solvents for the dyes The buffered distilled water solution

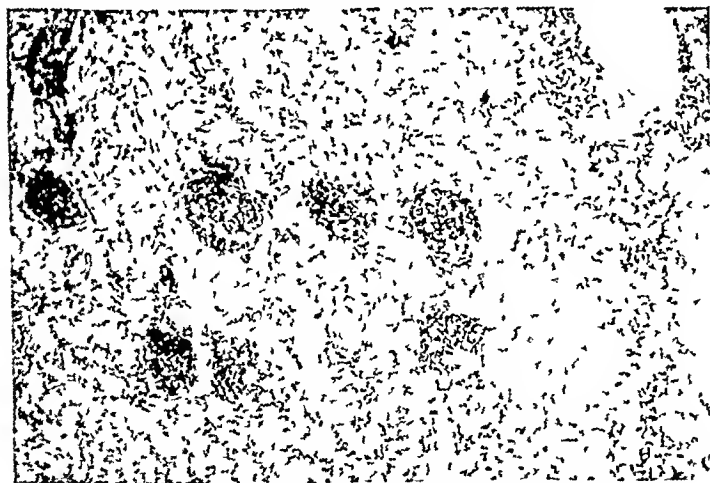


FIG 2B—Same dog as above Sclerosis and round celled infiltration of kidney glomeruli

was prepared by adding 0.300 gm of potassium dihydrogen phosphate and 0.387 gm of dipotassium hydrogen phosphate to 100 cubic centimetres of distilled water The dyes were then added to the solvents and the mixture warmed just enough to hasten the solution process The solutions were finally allowed to cool down to room temperature

and filtered through filter paper Sterilization of the dye solutions with heat was found to be unnecessary by Burke and Newton,¹⁸ because the dyes are sufficiently antiseptic to render themselves sterile, while heat will change the hydrogen ion concentration of the solvents, diminish the antiseptic power and increase the toxicity In the preliminary experiments the dyes were injected with both solvents and in various doses It was found that there

was a slight precipitate in the 1-100 mercurochrome in the buffered distilled water. In the later experiments, therefore, gentian violet and acriflavine were dissolved in buffered distilled water while the mercurochrome was dissolved in 3 per cent sodium bicarbonate. In our experiments on the effect of



FIG 3A—Dog No 8792 twenty one days after injection of 10 mg of gentian violet per kilogram of body weight. Focal degeneration of liver

the dyes on the infectious lesion, we regularly used 5 mg per kilogram of body weight as the unit dose. For injection, we used Luer's 3-inch 22-gauge needles. This was found to be the smallest size which would deliver the dye rapidly into the circulation. In order to facilitate the introduction of the needle into the blood-vessel, the distal third was bent at a right angle. The needles were attached to a syringe with a small rubber tube. In our first experiments the injections were made into the abdominal aorta, about 2 centimetres above the bifurcation. This artery was chosen because it is a vessel comparable in size to the human brachial or femoral arteries and injections may be made very easily which will deliver the solution largely into one or the other lower extremity. In the later experiments, injections were made into the femoral artery in order to avoid the complication of a laparotomy.

The technic of the injection into the aorta was as follows. Under ether anaesthesia, the abdomen was opened by a low median incision. After the intestines were packed away from the field of operation, the abdominal aorta just above the bifurcation was steadied with

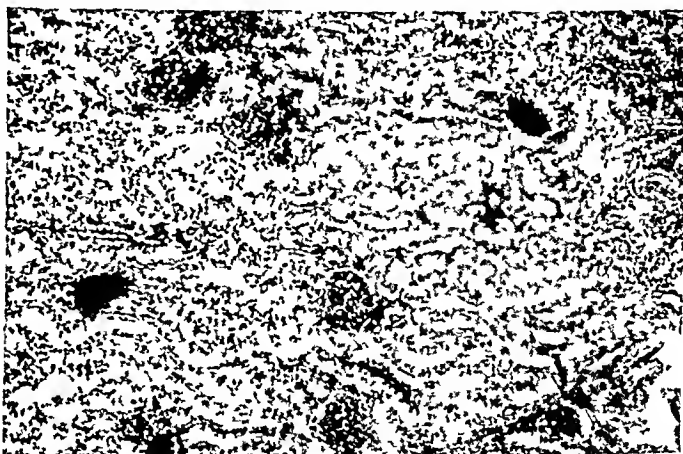


FIG 3B—Dog No 8755 twenty one days after the injection of 6 mg of gentian violet per kilogram of body weight. Sclerosis and round celled infiltration of kidney glomeruli, as well as a certain degree of cloudy swelling of the tubules

the fingers and the needle inserted into it through its anterior wall and guided into the right or left common iliac artery. Care was taken to minimize trauma to the vessel wall. To be sure that the needle was in the vessel and that no dye solution was retained in the rubber tubing, the injection of the dye was

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preceded and followed by normal saline solution. The dye was injected as rapidly as possible, avoiding leakage around the connections. At the conclusion of the injection the needle was gently withdrawn and immediately digital pressure was applied for a few minutes over the spot. By releasing this pressure at intervals of about a minute it was found that bleeding from the needle puncture rarely persisted for more than four or five minutes. Occasionally small local extravasation resulted, but this never became extensive enough to be of any consequence. Injections into the femoral artery were made through a small skin incision just below Poupart's ligament. Similar needles were employed.

The organism used to produce the lesion was a typical hemolytic *Staphylococcus aureus* isolated from a human infection. Twenty-four-hour broth cultures made from the stock culture were used throughout the experiment. With this organism we could produce constantly well-localized lesions in dogs. Redness, swelling, œdema, pain, tenderness, disability, fever from 101°–104° F, cellulitis and abscess were always present. The severity of the infection produced was fairly proportionate to the amount of the culture injected. In the first four instances 5 cubic centimetres of the culture were given. This was found to be unnecessarily large and it was therefore reduced to 2 cubic centimetres and finally to 1 cubic centimetre. The injections were made on the lateral aspect of one of the hind legs in a pair of dogs of approximately the same size and breed. Treatment was begun twenty-four, forty-eight or seventy-two hours after the injection of the organisms. We believe that only rarely would treatment in human cases be instituted before that time.

RESULTS

A Effect of the Dyes on the Animal and the Effect of the Needle on the Blood-vessel—Twelve normal dogs were selected and divided into three groups of four each. Of the first group, two dogs were given mercurochrome 220-soluble in buffered distilled water, and two dogs mercurochrome in 3 per cent sodium bicarbonate solution. The dosage varied from 2.5 mg to 16.6 mg per kilogram of body weight. Death promptly followed the injection of this latter dose and another dog was substituted and given a smaller dose. Of the second group, two dogs were given gentian violet in sodium bicarbonate and two gentian violet in buffered distilled water. The total amount of the dye received by each was 45 mg, 10 mg, 100 mg and 15 mg respectively. Through error the dogs of this group were not weighed before the injection and consequently the exact dosage per kilogram of body weight is not known but it was estimated to be from 1.5–10 mg per kilogram. In the third group two dogs were given acriflavine in sodium bicarbonate and two others acriflavine in buffered distilled water. The dose varied from 1.6 mg to 5.2 mg per kilogram of body weight. The results of these preliminary experiments are shown in Table I.

TABLE I

Showing the Effect of the Dye on the Dogs and the Needle Puncture on the Arteries

Dog No 8794 Dye solution used—mereurochrome in buffered water Dose—2 mg per kg Lived twenty-one days Cause of death—killed Pathological findings at autopsy—Artery—thickened intima, loss of internal elastic membrane Organs normal except kidneys, heavy glomerular round-celled infiltration

Dog No 8836 Dye solution used—mercurochrome in buffered water Dose—5 mg per kg Lived nineteen days Cause of death—lung abscess Pathological findings at autopsy—Artery—slightly thickened intima Organs—Lungs—multiple abscesses Kidney—general but especially glomerular round-celled infiltration Liver—diffuse degeneration

Dog No 8795 Dye solution used—mereurochrome in buffered water Dose—166 mg per kg Lived one day Cause of death—suppression of urine Pathological findings at autopsy—Artery—slight hæmorrhage in wall Organs—no change seen except kidneys—glomeruli choked with red-cells, polymorphonuclears and cellular debris, tubular degeneration

Dog No 8806 Dye solution used—mercurochrome in sodium bicarbonate Dose—25 mg per kg Lived twenty days Cause of death—diarrhoea Pathological findings at autopsy—Artery—irregular thickening of wall Organs—no change except kidneys—glomerular round-celled infiltration

Dog No 8807 Dye solution used—mereurochrome in sodium bicarbonate Dose—5 mg per kg Lived twenty-eight days Cause of death—killed Pathological findings at autopsy—Artery—thickened intima, break in internal elastic membrane Organs—Liver—congestion and patchy necrosis Kidneys—diffuse round-celled and polymorphic infiltration

Dog No 8793 Dye solution used—gentian violet in buffered water Dose—15 mg per kg Lived twenty-one days Cause of death—killed Pathological findings at autopsy—Artery—thickened intima Organs—no change except kidneys—hyaline changes in glomeruli, sinusoids choked with red-cells

Dog No 8792 Dye solution used—gentian violet in buffered water Dose—10 mg per kg Lived twenty-one days Cause of death—killed Pathological findings at autopsy—Artery—thickened intima Organs—Liver—focal necrosis Kidneys—diffuse cloudy swelling of tubules and sclerosis and round-celled infiltration of glomeruli

Dog No 8767 Dye solution used—gentian violet in sodium bicarbonate Dose—1 mg per kg Lived twenty-one days Cause of death—killed Pathological findings at autopsy—Artery—thickened intima Organs—Liver—patchy areas of degeneration Kidneys—glomerular round-celled infiltration Lungs—inflammatory exudate

Dog No 8755 Dye solution used—gentian violet in sodium bicarbonate Dose—6 mg per kg Lived twenty-one days Cause of death—killed Pathological findings at autopsy—Artery—thickened intima, blood pigment Organs—no changes except kidneys—glomerular round-celled infiltration

Dog No 8808 Dye solution used—acriflavine in buffered water Dose—2 mg per kg Lived twenty-eight days Cause of death—killed Pathological findings at autopsy—Artery—slightly thickened intima Organs—no changes except liver which shows slight diffuse degeneration

Dog No 8809 Dye solution used—acriflavine in buffered water Dose—5 mg per kg Lived twenty-eight days Cause of death—killed Pathological findings at autopsy—Artery—slightly thickened intima Organs—Liver—patchy necrosis and cellular infiltration Kidneys—some tubular degeneration and glomerular sclerosis

Dog No 8823 Dye solution used—acriflavine in sodium bicarbonate Dose—15 mg per kg Lived thirty-two days Cause of death—killed Pathological findings at autopsy—Artery—thickened intima Organs—post-mortem changes in kidneys, liver and lungs Spleen—large areas of necrosis

Dog No 8822 Dye solution used—acriflavine in sodium bicarbonate Dose—4 mg

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per kg Lived thirty-five days Cause of death—killed Pathological findings at autopsy
—Artery—thickened intima Organs—extreme congestion of liver and kidneys

Only three dogs showed any ill-effects following the injection of the dyes into the aorta. All three of these had received mercurochrome. One received a unit dose of 5 mg per kilogram of body weight of mercurochrome in buffered distilled water. He died with multiple pulmonary abscesses. Diffuse round-celled infiltration was found in the kidneys and diffuse degeneration of the liver. One other received half the unit dose in sodium bicarbonate. This dog developed diarrhoea the next day and died twenty days later. Glomerular round-celled infiltration of the kidneys, slight injection of the intestinal wall and a few enlarged oedematous lymph-glands in the mesentery were present at autopsy. Whether mercurochrome was responsible for the diarrhoea and death in this case is not certain. The third dog received three and three-fifths times the unit dose of mercurochrome in buffered distilled water. Within a few hours he became violently ill with persistent vomiting and scanty reddish-yellow urine. The skin of the hind leg on the injected side was pink in color. The dog succumbed within twenty-four hours of the injection. At autopsy the skin and the muscles of the leg on the injected side and the cortices of both kidneys were found to have been stained pink. The remaining dogs all survived the injections and were killed with chloroform at the end of three to five weeks. Immediate autopsies were performed on all the animals, paying particular attention to that part of the abdominal aorta where the injection was made, to determine the effect of the needle puncture on the vessel. There was no evidence of thrombosis of the vessels. In some instances no trace of the needle puncture could be made out, while in others the only macroscopic evidence of the needle puncture was a faint brownish spot. The abdominal and thoracic organs presented no gross pathology. Microscopic studies of the wall of the aorta at the point of injection, when it could be found, showed at most a slight proliferation of the intima with a break in the internal elastic membrane.

The effect of the dyes on certain of the organ tissues is indicated in the brief description of the pathological findings in Table I. It is evident that even when the animals survived, following doses as small as 1 mg per kilogram of body weight, after three or four weeks there was evidence of damage to kidney, liver or both and, with the larger doses, very extensive destruction of these tissues occurred. The pathological examinations seemed to show that gentian violet was least toxic and this was therefore used more than the other dyes in the later experiments. Pathological changes are shown in Figs 1, 2, 3 and 4.

B *The Effect of Intraaortic Injections of Dyes on Local Staphylococcus Lesions in the Leg*—The lesions were produced in a pair of dogs by injecting equal amounts of whole staphylococcus culture into the subcutaneous tissue of the outer side of the hind leg. The dogs were examined daily and temperatures were taken. When the time came for injection of dye, if there was any difference between the extent or degree of the lesion in the two animals, the dog showing the more severe lesion was selected for treatment. The dog to be treated was prepared and anæsthetized in the same manner as in the preliminary experiments. The abdomen was opened and the dye injected through the aorta into the iliac artery on the side of the lesion. The first control dogs were not subjected to any operation. With the last pair, however, the control dog was operated upon and saline was injected instead of dye. The results of these tests are shown in Table II.

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TABLE II

Showing the Effect of Intraaortic Injection of Dye on Local Infection

Dog No 8844 Dose bacteria—5 c c Time of treatment—72 hours Dye solution used—gentian violet in buffered water Dose—5 mg per kg Died fourth day Pathological findings at autopsy—(positive culture of hemolytic staphylococcus from peritoneum at time of injection of dye) Artery—thickened intima, broken internal elastic membrane Organs—Lungs—œdema Liver—diffuse hepatitis Spleen—miliary abscesses Kidneys—diffuse cellular infiltration Muscle necrosis and cellular infiltration Positive blood culture

Dog No 8843 Dose bacteria—5 c c Normal sixth day Autopsy—not examined

Dog No 8865 Dose bacteria—5 c c Time of treatment—72 hours Dye solution used—gentian violet in buffered water Dose—5 mg per kg Died fifth day Pathological findings at autopsy—(positive culture of hemolytic staphylococcus from peritoneum at time of injection of dye) Artery—very little evidence of injury Organs—Lungs—œdema and exudate Pleural fluid, peritoneum and blood positive culture Liver—degeneration around central vein Spleen—polymorphic infiltration Kidneys—congestion and capillary hæmorrhage

Dog No 8864 Dose bacteria—5 c c Normal twelfth day Autopsy—not examined

Dog No 8890 Dose bacteria—2 c c Time of treatment—24 hours Dye solution used—gentian violet in buffered water Dose—5 mg per kg Died fifth day Pathological findings at autopsy—Artery—thickened intima, active fibroblasts of early repair Organs—Peritonitis positive culture Blood culture negative Kidneys—cloudy swelling Liver and lungs congested

Dog No 8889 Dose bacteria—2 c c Normal ninth day Autopsy—not examined

Dog No 8918 Dose bacteria—2 c c Time of treatment—24 hours Dye solution used—acriflavine in buffered water Dose—5 mg per kg Normal eleventh day Autopsy—not examined

Dog No 8917 Dose bacteria—2 c c Normal seventh day Autopsy—not examined

Dog No 8928 Dose bacteria—2 c c Time of treatment—48 hours Dye solution used—acriflavine in buffered water Dose—5 mg per kg Normal sixth day Died seventeenth day Pathological findings at autopsy—Artery—thickened intima, frayed out internal elastic membrane Organs—Liver—diffuse hepatitis and necrosis Kidney and spleen—diffuse degeneration Lungs—lobular pneumonia

Dog No 8929 Dose bacteria—2 c c Normal third or fourth day Autopsy—not examined

Dog No 8953 Dose bacteria—1 c c Time of treatment—48 hours Dye solution used—acriflavine in buffered water Dose—5 mg per kg Died eighth day Pathological findings at autopsy—Artery—thickened intima, loss of internal elastic membrane Organs—Liver—patchy necrosis Lungs—pneumonia and focal abscesses Kidneys—cloudy swelling Spleen—congestion

Dog No 8954 Dose bacteria—1 c c Normal fourth or fifth day Died twenty-sixth day Pathological findings at autopsy—pneumonia Tissues not examined

Dog No 9093 Dose bacteria—1 c c Time of treatment—24 hours Dye solution used—mercurochrome in sodium bicarbonate Dose—5 mg per kg Normal seventeenth day Autopsy—not examined

Dog No 9094 Dose bacteria—1 c c Injection solution used—normal saline Normal tenth day Died seventeenth day Pathological findings at autopsy—distemper Tissues not examined

The treated dogs in which infection was produced with 5 cubic centimetres of staphylococcus culture, died on the fourth and fifth day in spite of the dye therapy, while the controls recovered Of those dogs which had a smaller dose of hemolytic staphylococcus, one treated with gentian violet died on the fifth day and one treated with acriflavine devel-

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oped bloody diarrhoea and died on the eighth day. The difference in the number of days that these dogs took to recover from the infection is striking. In no instance did a treated dog return to normal before its control. An average of eleven and three-tenths days were required for the treated dogs which survived to overcome the infection, and seven and two-sevenths days for the controls.

C The Effect of Injection of Dye into the Femoral Artery on the Local Staphylococcus Lesions in the Leg—The lesions were produced in the same way as in the preceding series. The injection of dye was made on the designated day following the development of the infection. The femoral artery was exposed below Poupart's ligament and the injection was made in the same manner as in the aorta. The control dogs were subjected to the same operative procedure as the treated dogs, but normal saline was given instead of the dye. The results are shown in Table III. In none of the dogs was there observed any circulatory disturbance in the leg suggesting thrombosis of the artery as a result of the injection. At autopsy the intimal surface of the artery was always found to be smooth and the needle puncture was occasionally marked by a very faint brown spot. In those specimens which were examined microscopically, a thickening of the intima was found without any loss of internal elastic membrane (See Fig. 1). The operative wounds healed by primary union in all cases and there was no evidence of the infection having been aggravated by the operative procedure except in one instance in which, after treatment with dye, the infection increased and spread upward to the abdominal wall the day following the operation. This dog was finally killed with chloroform and culture of the peritoneal cavity showed hemolytic staphylococcus aureus and bacillus coli. The other dogs all survived. The treated dogs returned to normal after an average of twelve and two-tenths days, while the control dogs became normal after an average of five days, excluding one dog in which the ulcer resulting from the sloughing of part of the skin over the infection refused to heal. This dog developed distemper on the third day and died on the thirty-fourth day.

TABLE III

Showing the Effect of Intraarterial Injections of Dye Into Femoral Artery on Side of Local Lesion

Dog No. 9119. Dose bacteria—1 c.c. Time of treatment—twenty-four hours. Dye solution injected—gentian violet in buffered water. Dose—5 mg. per kg. Appearance of lesion day of operation—leg swollen and hot, with discolored areas. Normal, general, tenth day, local, twenty-second day.

Dog No. 9118. Dose bacteria—1 c.c. Time of treatment—twenty-four hours. Solution injected—saline. Appearance of lesion day of operation—leg swollen, tense and hot. Normal, general, seventh day, local, 00. Died twenty-fourth day.

Dog No. 9167. Dose bacteria—1 c.c. Time of treatment—forty-eight hours. Dye solution injected—gentian violet in buffered water. Dose—5 mg. per kg. Appearance of lesion day of operation—leg swollen, hot, red and disabled. Moribund sixth day—(chloroformed).

Dog No. 9166. Dose bacteria—1 c.c. Time of treatment—48 hours. Solution injected—saline. Dose—5 mg. per kg. Appearance of lesion day of operation—leg swollen, hot, red and disabled. Normal third day.

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Dog No 9270 Dose bacteria—1 c c Time of treatment—24 hours Dye solution injected—mercurochrome in sodium bicarbonate Dose—5 mg per kg Appearance of lesion day of operation—leg swollen, hot, red and disabled Normal eighth day

Dog No 9269 Dose bacteria—1 c c Time of treatment—24 hours Solution injected—saline Dose—5 mg per kg Appearance of lesion day of operation—leg swollen, hot, red and disabled Normal sixth day

Dog No 9190 Dose bacteria—1 c c Time of treatment—48 hours Dye solution injected—mercurochrome in sodium bicarbonate Dose—5 mg per kg Appearance of lesion day of operation—leg swollen, hot, red and disabled Normal fourteenth day

Dog No 9189 Dose bacteria—1 c c Time of treatment—48 hours Solution injected—saline Dose—5 mg per kg Appearance of lesion day of operation—leg slightly swollen, moderate disability Normal third day

Dog No 9300 Dose bacteria—1 c c Time of treatment—24 hours Dye solution injected—acriflavine in buffered water Dose—5 mg per kg Appearance of lesion day of operation—leg swollen, hot, red and disabled Normal ninth day

Dog No 9299 Dose bacteria—1 c c Time of treatment—24 hours Solution injected—saline Dose—5 mg per kg Appearance of lesion day of operation—leg swollen, hot, red and disabled Normal seventh day

Dog No 9316 Dose bacteria—1 c c Time of treatment—48 hours Dye solution injected—acriflavine in buffered water Dose—5 mg per kg Appearance of lesion day of operation—leg moderately swollen, slightly red, disabled Normal eighth day

Dog No 9317 Dose bacteria—1 c c Time of treatment—48 hours Solution injected—saline Dose—5 mg per kg Appearance of lesion day of operation—leg moderately swollen, slightly red, disabled Normal sixth day

DISCUSSION

Our experiments demonstrate that small needles may be inserted into dogs' arteries as large as the aorta and as small as the femoral without causing a thrombosis or an aneurism and without significant injury to the wall itself. The concentration of dye as it reaches the site of infection depends upon the concentration of the solution and the speed of injection. It is certainly considerably greater than when the dye is injected intravenously. How much of the dye reaches the lesion in this concentration is problematical. At most it can only be that portion which enters the blood-vessels going to that focus and must be a very small part of that which is injected. The larger portion passes into the tissues, is taken up by the endothelial cells, or passes over to the venous side. Probably the largest quantity passes over and behaves as if it were injected intravenously. Certainly in our experiments enough dye passed through the peripheral capillaries to damage the liver and kidneys even when given in small doses.

Considering only that portion of the dye which enters the vessels leading to the site of the infection, it is evident that where the pathways are clear some of the dye may be taken up by the infected tissues and come in contact with the organisms, while some passes through the capillaries and enters the venous side. Also where the pathways are closed, as by thrombosed blood-vessels, the dye cannot come in contact with the organisms in the tissues. The question at once arises whether it is ever possible to bring any chemical into contact with bacteria diffusely scattered through the tissues.

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as in cellulitis or localized as in abscesses. An area of cellulitis might be infiltrated with such a drug, but it would seem that only the periphery of an abscess could be reached. The ideal drug sought by chemotherapeutists is, of course, one which will not be held by any tissue nor cells other than the organisms which are being combated and one which will not be withdrawn from the circulation until contact is made with all the available organisms. It must first of all be readily diffusible through capillary walls and the capillaries must be open for its entrance into them. The chemical should not be one that will be fixed by tissue-cells but on the other hand should have a

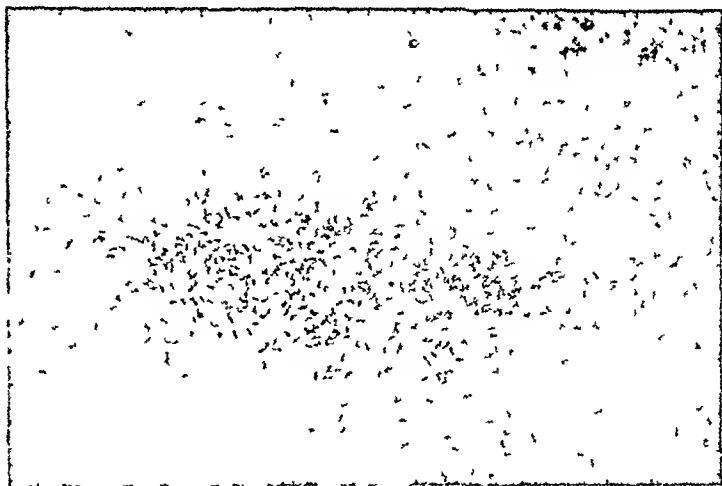


FIG 4A —Dog No. 8809 twenty eight days after the injection of 5 mg of acriflavine per kilogram of body weight. Focal degeneration of liver.

selective affinity for bacteria. We can only say that there is no evidence at hand that the dyes used in these experiments fulfill these requirements. Intra-arterial injection is theoretically better than intravenous injection because it delivers to the part affected the dye in "antiseptic concentration", at least

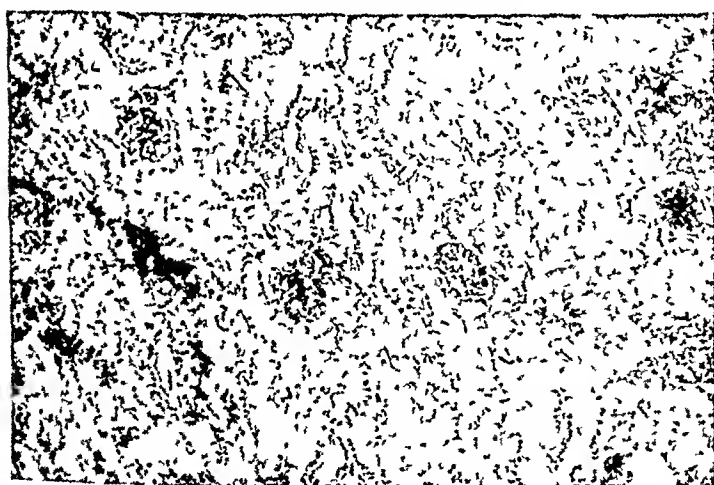


FIG 4B —Same dog as above. Glomerular and tubular injury of kidney.

for one cycle. That portion which passes over into the veins becomes diluted in the same way as if it were injected directly into the veins, and much of it becomes fixed in organ tissues throughout the body. Inasmuch as intraarterial injection may be done safely, this would seem to be the method of choice when a drug is found which will have

some or all of the ideal physical and chemical properties mentioned above.

It was of particular interest to obtain a positive culture of hemolytic *Staphylococcus aureus* in the peritoneal fluid of the dogs receiving the large dose of organisms in the leg. The dogs which were injected with dye died, but the control dogs which were not injected with dye lived. Although we cannot be certain that the control dogs had living organisms in the peritoneal fluid, it seems reasonable to think that they had, and may have survived because they were not subjected to the peritoneal trauma of operation as were

the treated dogs which were injected with dye. It is supposed that the organisms entered the peritoneal cavity by lymphatic extension upward from the thigh. In view of this result we were surprised to find that an incision into the tissues of the groin in the series of femoral artery injections did not result in a local infection at the site of injection. The dosage of organisms in the latter series was, however, much smaller.

It is significant, we think, that not one treated dog in either series returned to normal before its control. It is true that the dog with the worse lesion in every instance was used for treatment in order to favor the control, but there was not enough virtue in the medication to offset this handicap in a single case. On the other hand, the results suggest that the medication may have been a factor in retarding the return of the tissues to normal, but of this we cannot be certain. The lesions of the kidney and liver in the first group of dogs suggest that the dyes may, indeed, interfere with certain functions of the liver and kidney which are important for the resistance to infections in these animals.

SUMMARY

1 Certain experiments have been carried out in an attempt to demonstrate the effect of the dyes mercurochrome 220-soluble, gentian violet and acriflavine when injected into the aorta or the femoral artery of dogs.

2 In a series of thirteen dogs these dyes were injected into the aorta after solution either in buffered distilled water or in 3 per cent sodium bicarbonate in concentrations of 1/100 and 1/1000 and in dosage varying from 1 to 16 mg per kilogram of body weight. The effects of the needle puncture and the dye on the artery and the dye on certain organ tissue were observed. In no instance was there more than a trivial injury to the artery. No thromboses nor aneurisms occurred. No hæmatomas formed. In every instance even with the smaller doses there was some evidence of injury to the liver or kidney or to both, and with the larger doses there was extensive destruction of those organs when examined three to five weeks later. One dog died within twenty-four hours of injection with mercurochrome.

3 In a series of fourteen dogs acute inflammatory lesions were produced by injecting cultures of hemolytic *Staphylococcus aureus* into the subcutaneous tissues of the leg. In half of these dogs, the dyes were injected into the aorta in dosage of 5 mg per kilogram of body weight—twenty-four, forty-eight or seventy-two hours after the injection of the organisms. In no instance was there any evidence of delay or inhibition of the infection in the injected animals. Four of the treated animals died, while the corresponding control dogs, not receiving any treatment, survived. The other treated animals required on the average eleven and three-tenths days to return to a normal condition. The control dogs which were untreated returned to normal on an average of seven and two-sevenths days.

4 In a series of twelve dogs acute inflammatory lesions were produced in the same manner as in the preceding series. In half of these dogs the

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dyes were then injected into the femoral artery on the side of the lesion. In the six control dogs saline was similarly injected. One of the treated dogs died with an extension of the infection. One dog receiving dye and another receiving saline developed distemper. Of the other treated dogs there was no evidence of any delay or inhibition of the infection. The treated dogs required on the average twelve and two-tenths days to return to normal. The control animals became normal after an average of five days.

CONCLUSIONS

1 Intraarterial injection may be accomplished in dogs without injuring the artery significantly.

2 In our experiments there is no evidence that the intraarterial injection of the dyes, mercurochrome 220-soluble, gentian violet and acriflavine, in doses of 5 mg per kilogram of body weight, given twenty-four to seventy-two hours after the local injection of organisms into the leg, in any way affects the course of a local experimental hemolytic staphylococcus aureus infection other than to prolong it.

3 The intraarterial injection of these dyes in doses ranging from 1 to 16 mg per kilogram of body weight is regularly followed by damage to the kidneys or liver which persists for a month or more.

4 With the failure of this method of delivering the dye in concentrated form directly to the lesion through arterial channels, it could hardly be expected that intravenous injections of the same quantity would be efficacious in similar conditions.

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MYELOMA OF THE SPINE

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IN A recent article, Geschicter and Coneland¹ review all the literature and summarize the available data on all cases of multiple myeloma which have been reported since 1848. These authors give a fairly comprehensive review of our present knowledge of history, etiology, clinical characteristics, and treatment of the condition. In this paper I wish to report in detail another case of multiple myeloma, with particular reference to the diagnosis of the disease as it attacks the spine. The above authors do not emphasize this feature. Osgood and others have pointed out the difficulties in the ante-mortem diagnosis of myeloma of the spine, but none of them has given a very clear conception of the criteria upon which the diagnosis may be based.

From time to time during the study of the case here reported, various diagnoses were suggested by the symptoms and signs present. The patient gave a history suggesting a degenerative disease covering a six months' period prior to coming under observation. His history also suggested tuberculosis, and upon several occasions the chest findings tended to bear out this diagnosis. There was a peculiar blood picture which could not be explained upon the basis of any condition of which we were aware. Interesting alteration in the blood chemistry was also noted. There were never any symptoms referred to the long bones, pelvis or skull, and yet at autopsy these structures were found to be widely invaded by tumor. Because of the unusual and apparently misleading symptoms, the physical, roentgenological and pathological findings, it will be of interest and value to present the detailed history and laboratory data.

CASE REPORT.—A Roumanian laborer, age thirty-one, came with the complaint of weakness dating from an acute illness six months previously. This attack had been characterized by cough and pain in the right side of the chest. These symptoms persisted for six weeks. The patient never regained strength and was unable to return to work. He had lost about seventeen pounds weight. There were no symptoms referable to any other organs than the lungs, except for a recurring eruption on the arms and face. The rest of the past history and family history offered no clues as to the cause of the complaint.

Physical examination revealed evidence of recent weight loss. There was an extensive follicular eruption over the upper extremities and face. The percussion note over the right lower chest was markedly impaired and the breath sounds were diminished. A few dry wheezing rales were heard throughout the chest, and rather numerous fine subcrepitant rales over both bases. There was slight tenderness in the right flank on deep palpation but none over the lower ribs on the right. The spine revealed normal clinical findings. The temperature was normal but the leucocyte count was 16,000, with a differential count of 57 per cent polymorphonuclears, 1 per cent eosinophiles, 33 per cent small mononuclears, and 9 per cent large mononuclears. Urinalysis revealed a

few hyaline casts, red blood cells and a trace of albumin. The blood Wassermann was negative.

Because of the suspicious deep tenderness in the right flank, and the urinary findings, a kidney lesion was suspected. Routine roentgenograms were found negative. That portion of the ribs, spine and pelvis seen in these films appeared normal. A cyst-



FIG 1—Showing marked oste

all vertebrae and definite narrowing of the twelfth dorsal and second and third lumbar

stereoscopic examination was all calibre strictures of the ureters, demonstrated. The urologists were uncertain as to the relation between these findings and the patient's symptoms.

Stereoscopic films of the chest gave evidence of a slight amount of fluid in the right costophrenic angle and of a tuberculous process in the left upper lobe. The ribs appeared normal.

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As the patient continued under observation the findings remained about the same. Both ureters were dilated. Urine from the kidneys did not contain pus and was negative to culture on ordinary media. At each visit the leucocytosis in the neighborhood of 17,000 persisted in spite of clearing of the skin infection and apparent resolution of the chest pathology.

About eight weeks after the original examination the patient was sent into the hospital on the medical service with a recurrence of chest pain and eruption on the face and arms, and with the additional new symptoms of nausea and vomiting. The admission temperature was normal but there was again a leucocytosis of 18,000 with a high polymorphonuclear count. The patient received symptomatic treatment and gradually improved. About a month later he developed pain in the back so severe at times that he would fall to the floor. It was then that he first came under my observation. I believe the physical findings at that time were characteristic of myeloma of the spine, but I did not recognize them. The patient stood in a slightly stooped position, the weight of the body carried forward on the balls of the feet, and the feet wide apart. The spine was practically straight, the normal anteroposterior curves being decidedly decreased. All motions were executed with extreme caution and were considerably limited and very painful. There was tenderness along the lower dorsal and lumbar spine, both over the articular facets and directly over the spinous processes.

Rontgenograms of the spine showed a fusiform shadow about the level of the eleventh dorsal vertebra suggesting the possibility of a vertebral abscess. The symptoms and physical findings warranted a diagnosis of acute spinal arthritis, but that early Pott's disease, not demonstrable by X-ray, might be strongly suspected. Accordingly immobilization of the spine in plaster was advised and accepted by the patient.

Subsequent to the application of the plaster jacket the patient was very comfortable. A fortnight later the pain recurred with as much severity as before. The cast was



FIG. 2.—Showing circle was produced

tumor in right femur Fracture force post mortem

removed and the patient placed on a Bradford frame. The following day he developed severe nausea, vomiting, distention and inability to pass flatus. Peculiarly, the temperature was normal but the leucocytes numbered 26,000, with 74 per cent polymorphonuclears. The following day the leucocytes had risen to 39,000, and physical signs of an acute lobar pneumonia and symptoms suggesting an early meningitis had developed. The

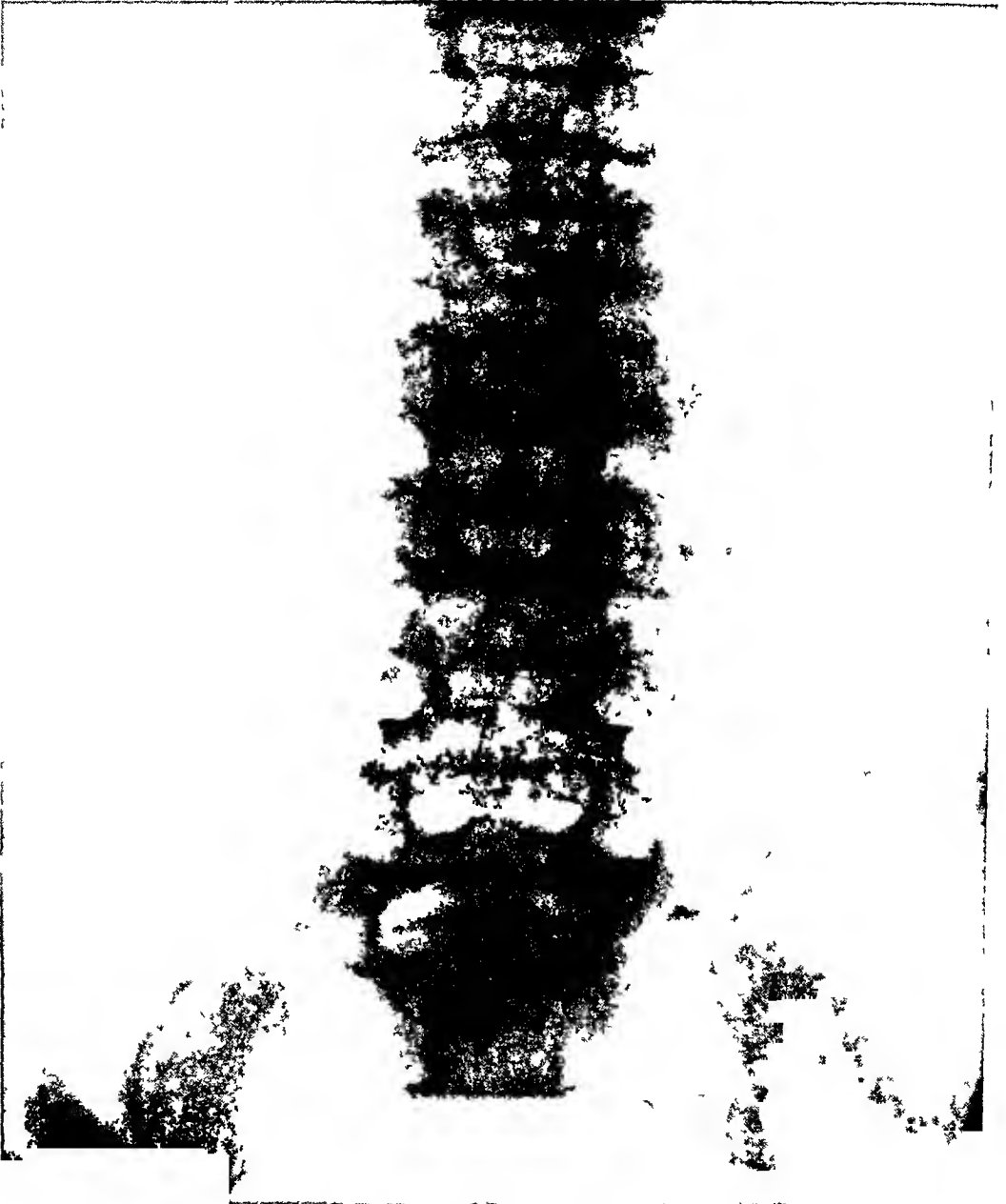


FIG 3—Taken post mortem. Showing widespread involvement of all bones. Appearance of spine is typical. Compare lateral view (Fig 5).

temperature rose to 103, the pulse was rapid and weak, but the respirations were normal in rate. Within four days the temperature had returned to normal, the above symptoms had all disappeared, but the leucocytes remained elevated. Repeated studies of blood smears showed slight change in size, shape and staining qualities of the red cells, occasional stippling of the red cells, but never any abnormal white cells. The color index was below 1.

A spinal puncture done because of the suspicious cerebral symptoms, revealed a

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typical parietic gold curve and a positive Pandy. It will be recalled that there was no history or clinical evidence of syphilis and that the blood Wassermann was negative.

Blood chemistry studies showed a non-protein nitrogen of 26, urea nitrogen 14.9, creatinine 1.5, sugar 91, phosphorus 3.36-4.08 and calcium 16.1. Unfortunately the importance of the abnormal calcium and its possible relationship to the disease were overlooked and only the single determination made.

From this time on, the patient's course was apparently one of gradual improvement with periods of relapse in which he was very ill. Rontgenograms of the spine (Fig. 1)

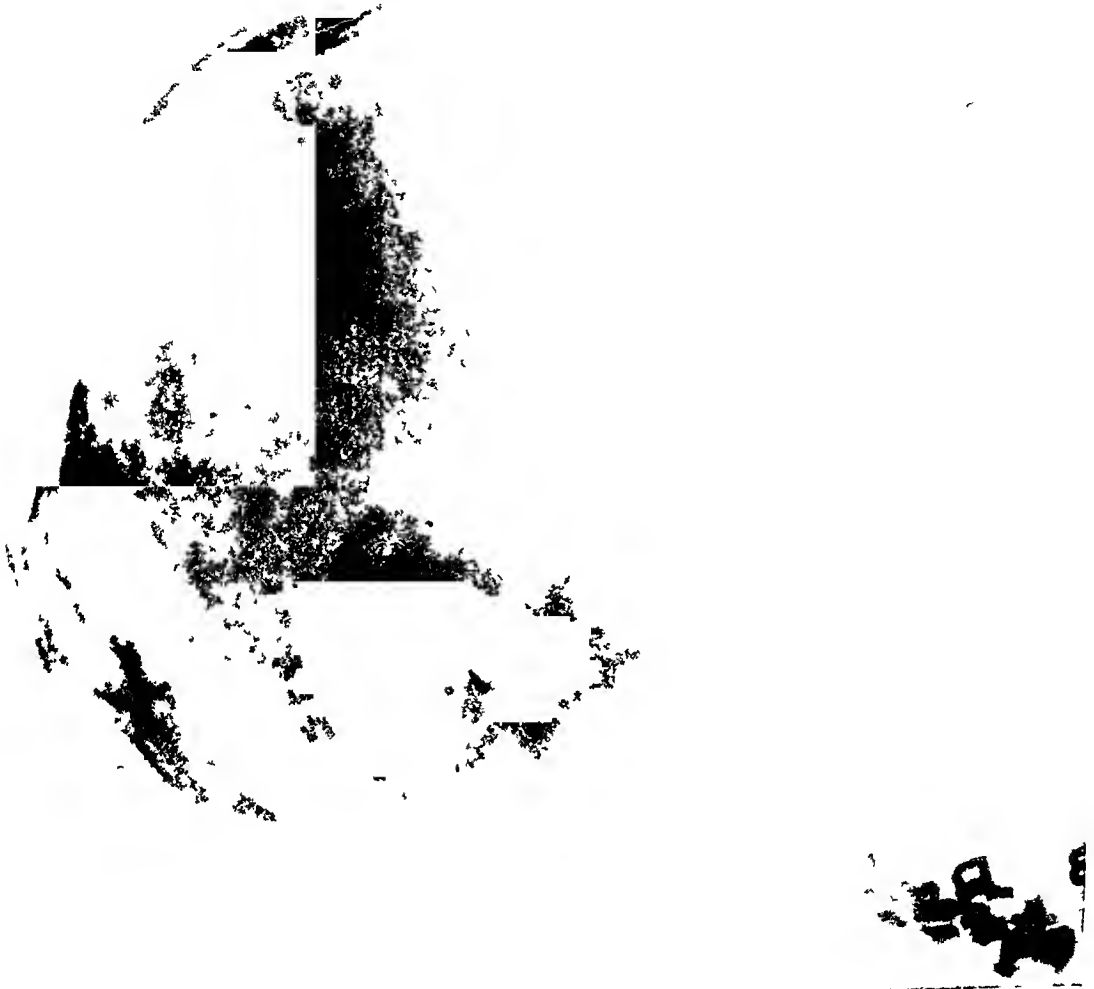


FIG. 4—Showing typical "worm eaten wood" appearance of myeloma in skull

taken about six weeks after the original ones, showed marked narrowing of the upper three lumbar vertebræ and of the last dorsal but no narrowing of the joint spaces. The lower ribs were normal. After a careful study of these films a diagnosis of myeloma was made on the basis of them. Because of the expense the patient would not permit X-ray studies of the entire skeleton. Bence Jones bodies were then demonstrated in two urine specimens after examining every specimen voided over a ten-day period.

The patient was then given deep X-ray therapy to the spine. Improvement was really remarkable. After two exposures he experienced complete relief of pain and was able to leave the hospital two weeks later. He was equipped with a spinal brace.

Of the subsequent history nothing is known. The patient died two months later at the county infirmary. The terminal symptoms were evidently pulmonary, as the

cause of death was given as tuberculosis. Fortunately I was able to have the body returned for an autopsy. This was performed by Dr C Z Garber. A resume of the important findings having a bearing on the subject of this paper follow.

Pathological Report—It is worthy to note that the lungs showed no evidence of tuberculosis, either old or recent. Both pleural cavities were nearly completely obliterated by dense fibrous adhesions and the visceral pleura was very much thickened. There was considerable oedema present.

There was no evidence of new growth in any of the viscera. The liver showed only chronic passive congestion. The spleen showed no gross evidence of pathological change.

The following dictation by the pathologist regarding the skeletal tissues is of particular interest.

"Section through the sternum shows a large central cavity filled with very soft coarsely granular, pinkish-red tissue. The ribs look to be smaller than normal. They are broken and cut with great ease. It is easier to cut the ribs than the costal cartilages. The central cavities of the ribs are small. They are filled with pinkish-red tissue. The right femur and upper third of the tibia and fibula are removed in one piece and longitudinal saw cuts are made through these bones. Externally they are not remarkable except for the fracture at the lower end of the femur, which was made while handling the body. The marrow cavity of the femur is seen to contain a very abundant amount of pinkish-red, coarsely granular, soft

FIG 5—Showing typical X ray appearance of myeloma of the spine. Taken post mortem with the spine dissected free and hemi-sectioned.

tissue. The cortex appears to be of normal thickness except at the ends of the bones, where it is thinned out to a mere shell. This is most marked in the lower end of the femur in the region of the fracture. There is no new bone formation. The area at the lower end of the femur shows the marrow cavity enlarged and occupied by a soft, mottled, pinkish-gray and brownish-gray tumor mass. Section of the tibia shows the marrow cavity rather large and containing yellow adipose tissue and showing some mottling of pink

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Section of the fibula shows a small marrow cavity which is yellowish-pink in color. Except for the upper cervical region the vertebral column is removed intact, the ribs being cut easily by means of an ordinary knife. The vertebral column is sawed in two and the bodies of the vertebrae are seen to be pinkish-red in color. The bony trabeculae have largely been destroyed, and many of the vertebral bodies are filled with soft, coarsely granular, pinkish-red tissue which is not much different from hyperplastic bone marrow in appearance. The process of sawing through the vertebral column is done very easily, showing the great loss of bone. The intervertebral cartilages are intact.

"The skull is easily sawed through. The calvarium measures 5 to 6 mm in thickness. There is a larger amount of pinkish-red marrow-like tissue than is usually found. There are no large definite areas of tumor. Dura is not remarkable. Numerous sections of the brain show no abnormalities. The posterior clinoid processes of the sphenoid are much more easily broken than is usually the case."

At this point it is well to emphasize the fact that even though those parts of the femur, tibia and fibula which were removed from the body showed gross evidence of rather diffuse tumor involvement only the ends of those bones revealed very definite X-ray evidence of the disease. Rontgenograms taken post-mortem of all the long bones showed rather circumscribed areas of rarefaction near the epiphyses.

Microscopic Notes—Sections through the large mass of tumor at the lower end of the right femur show it to be composed of a network of rather small, definitely outlined, irregularly shaped cells with rather scanty bluish pink staining cytoplasm often extending in the form of delicate processes and fairly large round oval nuclei which stain dark bluish-black or show chromatin in more open coarsely granular form. A few mitotic figures are found. There is a lac-like, delicate, fibrous, connective tissue stroma and the tumor cells appear to grow out from it so that there is a suggestion of an alveolar arrangement. Capillaries containing red blood cells are occasionally visible in the stroma. There is a little variation in the size of the tumor cells and some have two nuclei. A few red blood cells are noted scattered among the tumor cells of certain areas but no normoblasts are identified. Several narrow bone trabeculae are seen with a good deal of rather loosely woven connective tissue round about.

A section taken through the marrow at the upper end of the right femur shows some evidence of normal bone marrow structure in that there are hollow spaces which are judged to have formerly contained fat. There is a delicate fibrous connective tissue stroma which is more diffuse and shows no suggestion of alveolar arrangement. There are some normoblasts and irregularly-shaped cells similar to those described above except that they contain numerous small pink or bluish-pink staining granules. Many cells show lobulated nuclei.

Another section from the upper end of the femur was made from a decalcified block. Some of the cortical bone remains but it is much thinner than normal. Bony trabeculae are numerous but smaller than normal. Some normoblasts, giant cells, and neutrophilic and eosinophilic myelocytes are seen, but most of the cells are of the more embryonic type.

Sections from the vertebrae show but little fat and the marrow cells are rather close together. Myelocytes of the neutrophile and eosinophile types, and a rather small number of normoblasts, red blood cells, polymorphonuclear neutrophiles, eosinophiles and giant cells are seen, but most of the cells are of the more embryonic type, such as have been described above. They are irregular in outline and vary somewhat in size but have a moderate amount of bluish-pink staining cytoplasm and relatively large nuclei which are round or oval and have their chromatin in a granular arrangement. Bony trabeculae are less numerous than normal and are long and very narrow. In some places they are surrounded by a zone of fibrous tissue which looks like compressed reticulum.

Another section from a decalcified block of vertebrae shows practically the same picture. The predominance of the embryonic type of cell is, however, even more marked. A few mitotic figures are seen. The cortex of the bone is largely destroyed and in

most areas the characteristic cells border directly and are sometimes seen to be invading the dense fibrous tissue of the periosteum

Discussion—Geschicter and Copeland emphasize the fact that the distribution of the tumors in multiple myeloma is perhaps the most outstanding diagnostic feature of the disease. These authors believe that there is multiple involvement of the ribs, sternum, or clavicles and spine in ninety per cent of all cases, and that in rare instances the disease may involve the spine only or the ribs only. Ewing² states that the ribs and sternum form the usual original sites of the disease and that the skull, femur, pelvis and humerus are less often involved and in the order named. This is rather contrary to the idea conveyed by Geschicter and Copeland. In a report of thirteen cases from the Mayo Clinic, Meyerding³ gives the impression that the spine is rather often the seat of primary involvement.

While the evidence is inconclusive, it points to the primary involvement of the spine in the case here reported. It will be recalled that at no time while under my observation did this patient complain of pain referable to any bones except the spine and ribs. The chest pain was easily explainable on the basis of lung pathology, and repeated roentgenograms of the ribs were negative for signs of neoplasm. Also in favor of the spine as the primary site of the growth was the widespread involvement of all the vertebræ in spite of protection from the effect which weight bearing and motion might have had in disseminating the growth.

The first and most outstanding symptom in all reported cases of myeloma was pain. This may be rheumatic in character and rather indefinite at first. It may be referred to the corresponding nerve root areas. The pain is aggravated by movement or pressure and is subject to remissions and exacerbations. In the above patient, the initial attack of pain was brought on by cranking an automobile and was of sufficient severity to completely prostrate him. Geschicter and Copeland convey the idea in their report that in all cases of myeloma, back pain is characteristic, but they do not explain the mechanism of the pain. The cases of myeloma with spinal involvement which have been reported have had back pain as a common symptom. I believe this pain is due to erosion of the periosteum from within, by the advancing growth and to nerve root pressure accompanying the softening and collapse of the vertebræ. In the absence of definite spinal involvement back pain is difficult to explain.

The change in shape of the vertebræ mentioned above causes a progressive deformity of the spine. This is the next most characteristic clinical sign of myeloma of the spine. The stature may be actually reduced as in Paget's disease of the bone. The normal antero-posterior curves are changed as the vertebral bodies narrow. As pointed out by Geschicter and Copeland, the deformity of the trunk leads to a characteristic habitus or stance with protruding abdomen, and shoulders thrown back and the head forward, the feet well apart to give a wide base for standing.

The laboratory findings, while not particularly characteristic of myeloma of the spine, may be mentioned briefly as aids in diagnosis. In the majority of

cases there is a secondary anaemia. The white blood cell and differential counts present certain peculiarities. These are discussed in detail by Geschicter and Copeland. Suffice it to say here that a leucocytosis has been present in twenty-three per cent of reported cases and was explained frequently by the presence of secondary infection. In others it was probably due to the disturbance in the bone marrow. The leucocytosis in our patient was certainly disproportionate to infection and fever. It seems reasonable to expect some pathological change in the histology of the white blood cells and in the count. Careful blood studies should be made in all suspected cases.

The presence of Bence Jones bodies in the urine, often looked upon as a classical sign of the disease, has been noted as early as the eleventh week and as late as the fifth year. They may be present intermittently or continuously. They sometimes appear in showers similar to the appearance of casts in certain forms of nephritis. Meyerding⁴ believes these peculiar bodies to be present in the urine of eighty per cent of cases. They were found in half the cases reviewed by Ewing, but in the review of Geschicter and Copeland in sixty-five per cent. I am inclined to believe that they are present in all cases sometime during the course of the disease, but that they are difficult to find. Emerson⁵ states that in those cases in which Bence Jones protein is found in the urine, it is usually present in concentrations of less than one per cent. Most patients whose urine contains Bence Jones bodies die in less than two years. One should not have to wait until these bodies are demonstrated to make the diagnosis of myeloma.

While Baetjer and Waters⁶ state that myeloma is difficult if not impossible to diagnose by X-ray, Kolodny⁷ and Meyerding believe that X-ray is the single most important factor in the diagnosis. The typical roentgenogram of myeloma in all bones except the vertebræ resembles worm eaten wood, with numerous areas of decreased density which vary in size and shape, most typically seen in the skull (Fig. 4).

At this point it is well to emphasize the numerous mistakes made in hospital and private practice, and freely admitted by various well-known men in the diagnosis of myeloma of the spine. While these mistakes may not have had any appreciable influence on the outcome or progress of the disease, avoiding them may obviate useless treatment and lead to an earlier and more correct prognosis. The reasons for these errors are several. First, the possibility of the disease is seldom in one's mind when examining backs in which lesions of the vertebræ are suspected. Other factors which lead to incorrect diagnoses are the rarity of the disease, the scarcity of reports in English on the subject, and the peculiar clinical course and misleading physical findings. Last, and most important, are the rather confused ideas regarding the X-ray findings.

Turner⁸ states that the roentgenograms of his cases were inconclusive for spinal pathology. Osgood⁹ makes the same statement in a report of three cases observed by him. Gaube¹⁰ reports a case in which it was impossible to establish a correct diagnosis because the roentgen examination failed to reveal the true condition. Reviewing the photographic copies of roentgeno-

grams accompanying the last three mentioned reports, and comparing them with those shown by Meyerding and Kolodny, and with those of this report, one finds them practically identical. It seems that the typical X-ray picture of myeloma of the spine, that which has often been regarded as confusing and indefinite, is one of extensive rarefaction (Fig 3 and Fig 5) of the bone with flattening of the bodies of the vertebræ but not much narrowing of the intervertebral cartilages. The only other conditions which might present the same picture are the rapidly growing sarcomata arising from bone marrow. However, these conditions would have other distinguishing features. There should be no mistaking the diagnosis of myeloma of the spine in roentgenograms such as presented here, and especially when combined with a peculiar history similar to the one given in this paper, and with the clinical characteristics enumerated above.

The reason for the peculiar appearance of roentgenograms of myeloma of the spine as different from other bones is possibly explained by the structure of the vertebral bodies, where the total amount of compact bone is less than in other parts of the skeleton. Consequently the tumor is more rapidly destructive and infiltrating and finally replaces all the normal bone, leaving a very thin cortex.

SUMMARY AND CONCLUSIONS

- 1 Myeloma of the spine is a rare disease, but one which should be kept in mind when examining for spinal pathology.
- 2 The clinical course and findings are rather definite. The apparent indefiniteness of the clinical signs is itself typical.
- 3 The absence of Bence Jones bodies from the urine does not preclude the possibility of the disease. The presence of these bodies should serve as confirmatory rather than indicative evidence.
- 4 There is often a disturbance in the blood picture. The blood should be carefully studied in all suspected cases.
- 5 The roentgenological findings are diagnostic.

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TRANSBUCCAL APPROACH TO THE ENCEPHALON

IN EXPERIMENTAL OPERATIONS UPON CARNIVORAL PITUITARY, PONS, AND VENTRAL MEDULLA

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IN THE course of frequent experimental intracranial operations during the past year, a transbuccal approach to the entire medioventral surface of the di-, mes-, met-, and myel-encephalon has been evolved as a reliable survival procedure, with a total mortality of 11 per cent for the series and without a single fatality in the last twelve of the seventeen operations. Despite the exceeding vascularity of the basilar fossæ the procedure is practically bloodless when properly carried out. The second, fifth, sixth, and twelfth cranial nerves have been cut at their source under direct vision, without damage to closely contiguous structures and many hypophysectomies have been done. It is not improbable that a visually controlled attack on the seventh-eighth nerve complex could be accomplished.¹

Knowledge of the pituitary body has recently been extended (Camus and Roussy³) by the use of a more exact operative approach (Bailey and Bremer², Dandy and Reichert⁵). A far-reaching hypothalamic (probably tuber cinereum) syndrome has been extricated with seeming definiteness from the hypopituitary complex described by Cushing.⁴ The development of experimental operative procedures has been sketched by Bailey and Bremer.² Gemelli,⁶ and later Aschner,¹ were the first to employ successfully a transbuccal route to the hypophysis. Aschner's operative methods enabled him to obtain results with only slight incidental injury to the tuber cinereum. His series of seventy-nine operations comprised sixty-three total hypophysial extirpations and sixteen partial. Tabulation of these reported total extirpations shows that about 17 per cent died within the first three days (two instances of intentional tuber cinereum injury included), presumably of acute operative sequelæ, an additional 20 per cent died during the first month, often of distemper but also in about 12 per cent of the cases because of "palatal dehiscence and pneumonia." Dandy and Reichert's series of thirty-one dogs, in which a transtemporal procedure was used with puncture of the interpeduncular cistern and a "hanging brain" posture, had an immediate operative mortality of 16 per cent.

In 1923, Pollock and Davis⁸ described an operation for transbuccal approach to the basilar artery, their experiments were acute, no preparations

* Lateral column nerves of the medulla are more readily exposed by a posterior fossa ("cerebellar") exploration. The third and fourth nerves, and preponine hypothalamus are more readily approached by a modified transtemporal route.

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being kept longer than twenty-four-thirty-six hours. An elaboration of this was subsequently used by McLean⁷ for an aneurotraumatic approach to the pons.

Proper recognition of anatomical landmarks and an accurate visualization of underlying structures is necessary for proper placing of the necessary bony perforations. These are discussed below, but the accompanying

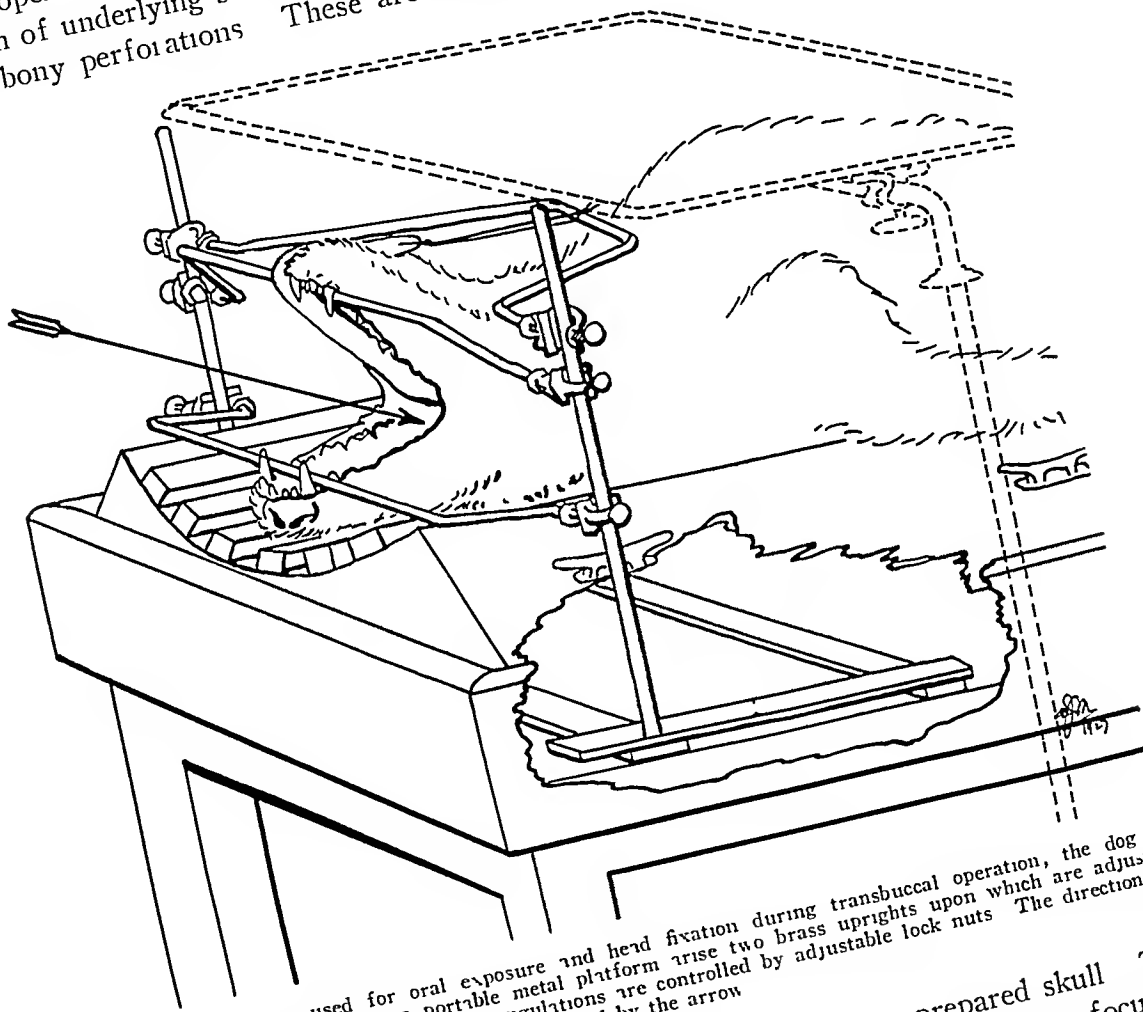


FIG 1.—Gag used for oral exposure and head fixation during transbuccal operation, the dog is lying on his back. From a portable metal platform arise two brass uprights upon which are adjusted three bent metal rods whose radial angulations are controlled by adjustable lock nuts. The direction of the operative field shown in Fig 2 is indicated by the arrow.

drawings cannot properly take the place of study of a prepared skull. The customary accessories of careful intracranial surgery are needed—a focusing beam headlight, a power drill, suction, irrigating saline, small cotton pledgets, bone wax, fresh muscle. An indispensable requisite is proper fixation of the head, and a wide oral exposure, this has been readily obtained by a sturdy modification of the gag devised by Pollock and Davis. It is essentially a steel platform (Fig 1) with brass rod uprights, so fitted that it may be accurately inserted beneath the latticed operating bed, three cross-rods of the shape shown may be adjusted at varying heights, and their radial angulation fixed by adjustable lock nuts. The one shown is suitable for dogs, puppies, and cats.

TRANSBUCCAL APPROACH TO THE ENCEPHALON

Operation—The day of operation the animal has no food. Anæsthesia may be induced by either (1) 90 mg/kg chloralose (warm 1 per cent aqueous solution) intravenously immediately before operation, preceded by 15 mg morphine and $\frac{1}{2}$ mg atropine subcutaneously, or (2) 2 cc/kg fresh paraldehyde by stomach tube ninety minutes before operation, the paraldehyde being preceded one-half hour by 30 mg morphine and 0.6 mg scopolamine subcutaneously, or by (3) 50 mg/kg amytal intraperitoneally forty minutes before operation, the anæsthetics are named in order of their preference. The anesthetized animal is placed on its back on the table, and the lower two rods of the gag, protected by rubber tubing, are placed just back of the canine teeth of the upper and lower jaws, a heavy silk stitch is placed through the tip of the tongue, which is drawn snugly forward and fastened to the upper rod. The animal is gavaged with 0.1 gm/kg of hexamethylenamine. Mouth is washed with saline cotton, and the entire buccal cavity, pharynx, and gingivæ painted with 1 per cent aqueous mercurchrome-220, tongue and floor of mouth painted as well with sterile liquid petrolatum. A dressing table is placed as shown in Figure 1, and the mouth is draped with four towels as shown in Figure 2, the corner towel clips conveniently catching the gag rods. The rest of the field is protected with sterile sheets. A gauze sponge damp with saline is placed in the roof of the mouth.

The soft palate is incised its full length, leaving $\frac{1}{2}$ to 1 cm of its posterior border intact. The posterior palatine arteries are caught for a few moments with hæmostats, but do not ordinarily require ligation. When the incision has first opened into the nasopharynx, it is quickly completed, and a moist cotton pledget with a silk thread attached is placed in the nasopharynx for tamponage at the border of the hard palate, to prevent oozing blood from collecting about the conchæ and giving a post-operative nasal discharge. Guy sutures catching both layers of mucosa are placed midway on either side of the incision for lateral retraction, and fastened to the drappings. Several small bits of palatal muscle are clipped free, and saved on gutta serena tissue for use later in hæmostasis, these should be taken early in the operation before there is possibility of unsterility.

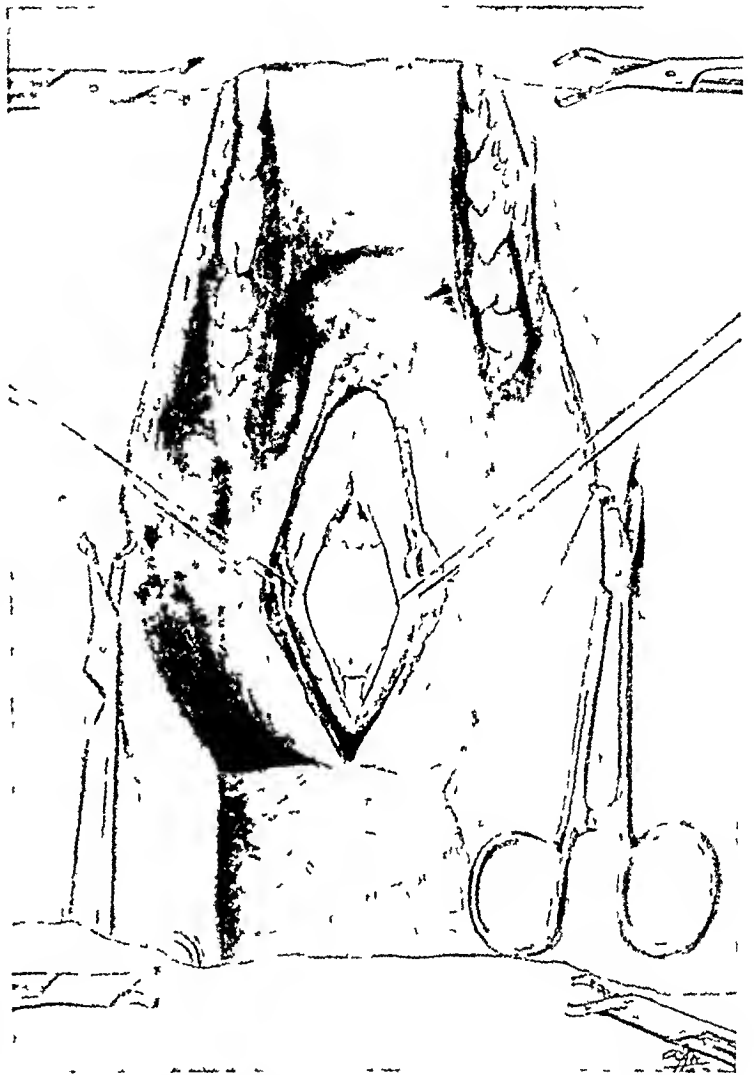


FIG. 2.—Operative field in transbuccal operation. The dog is lying on his back, lower jaw is in upper part of illustration, upper jaw and nose are covered by drapery of lower part of illustrated field. The soft palate has been split and retracted laterally, as has also the nasopharyngeal mucoperiosteum. Tongue, epiglottis, and tonsils are in upper part of illustration. Hard palate is covered with a gauze sponge. The hamulate processes, Eustachian orifices, intersphenoid suture, cranio-pharyngeal tract emissary vein, and occipitosphenoid suture are shown, the nasopharyngeal incision extends posteriorly to the midline dimple which marks the muscles originating from the porous occipitopetrosal ridge. Relations are shown as seen by the operator's oblique view.

The exposed nasopharynx is irrigated with saline (which is removed by suction), and painted with 1 per cent mercurochrome

Several landmarks are now in view (Fig 2) The hamulate processes of the os

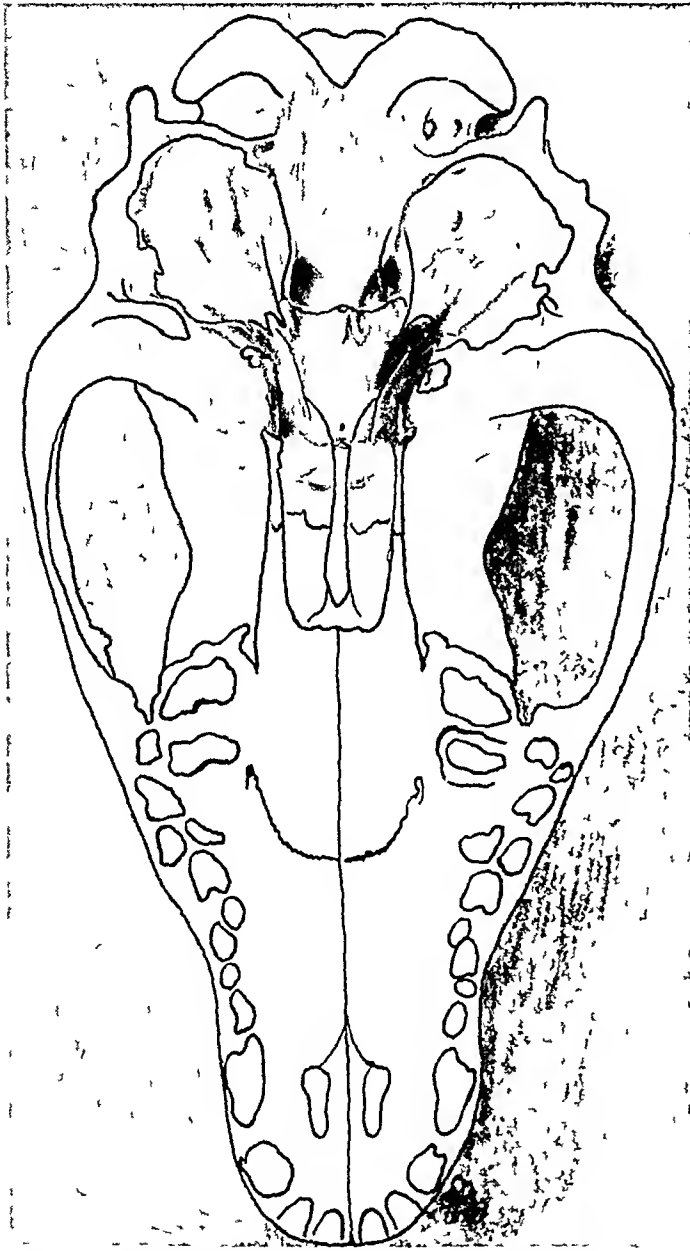


FIG 3—Composite view of inferior and superior surfaces of the basilar plate of the crine skull These relations must be constantly in mind The inferior (extracranial) surface is shown in outline, the superior (intracranial) surface is in half tone Fig 4 labels important landmarks Rostrad to the posterior clinoid processes lies a completely avascular area through which the pituitary body may be approached, this area has an abundance of landmarks—the hamulate processes, intersphenoid suture, and cranio-pharyngeal emissary vein mark its anterior border, and the occipito-sphenoid suture its posterior border, laterad to the avascular area are the cavernous venous sinuses which meet underneath the posterior clinoid processes to form the circular sinus Behind the posterior clinoids are the treacherously variable inferior petrosal sinuses

as far posteriorly as the stylomastoid tubercle from which the M biventer originates

A 3 to 4 cm midline incision is made in the mucoperiosteum, and a periosteal ele-

palatinus are sometimes seen, and are always palpable, beneath them in the operator's view are the slit-like orifices of the Eustachian tubes

In the midline posteriorly is the lambda-shaped dimple which marks the origins of the scalene-rectus capitis groups, and laterally underneath these the unmistakable tympanic bullæ are palpable About 15 cm back of the tympanic bullæ the foramen magnum can be palpated The midline incision in the nasopharyngeal mucoperiosteum is placed with reference to these landmarks The hamulate processes almost immediately overlie the intersphenoid suture which marks the anterior end of the avascular area of the sella turcica (Fig 3) Just back of the Eustachian orifice is palpable the tympanic bulla's bony spicule protecting the carotid, this almost exactly overlies the occipito-sphenoid suture which marks the base of the posterior clinoid processes, a few millimetres back of this suture also is the crotch of the lambda-shaped dimple mentioned above The midportion of the porous ridge of the os occipitale from which arise the muscles medially overlying the tympanic bullæ marks the cephalic border of the pons and the posterior edge of the treacherously variable inferior petrosal venous sinus running in the dura (Fig 5) This venous sinus sometimes, however, extends

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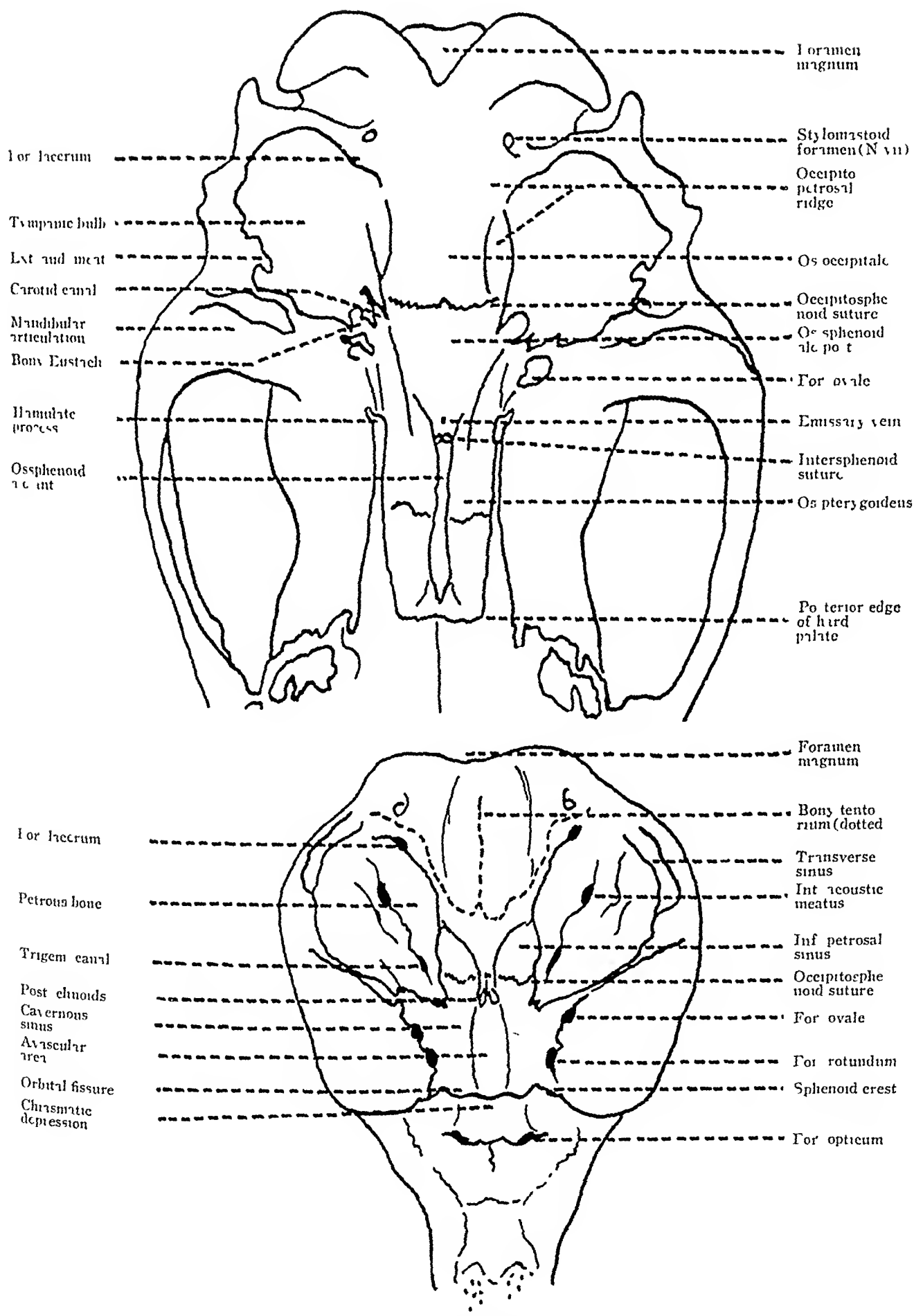


FIG 4—Key drawing for Fig 3. The upper half of the drawing labels structures of the inferior surface of skull, shown in outline in Fig 3. The lower half of the drawing labels the structures of the superior surface of the basilar plate of the skull, shown in half tone in Fig 3.

vator used to free this from underlying bone. On the care with which this is done largely depends the success of the operation, no rent should be made, for this layer must be later sutured back intact, if possibility of meningitis is to be avoided. A second pair of silk guy sutures is placed in the free edges of the mucoperiosteum and gentle adequate lateral retraction obtained. The exposed bone is sluiced with saline. The intersphenoid

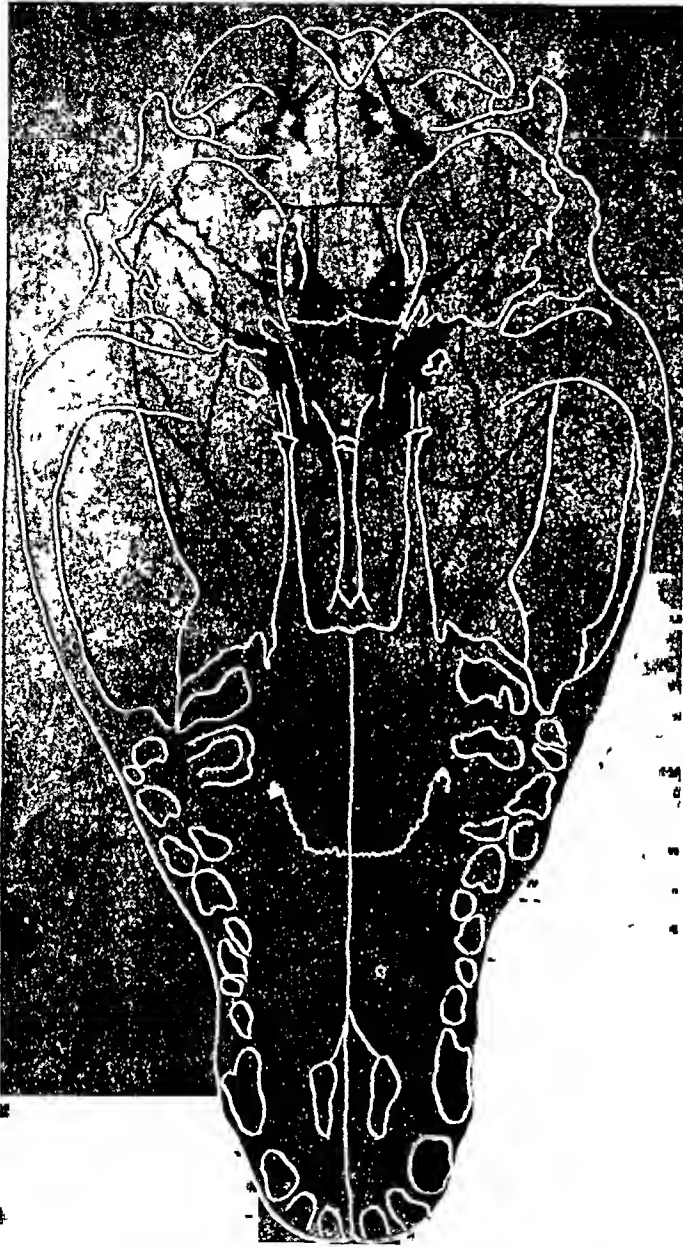


FIG 5—Semidiagrammatic view of inferior surface of the canine skull (white), showing location of venous sinuses (stipple), and relations of under surface of the brain (black)

suture and the occipitosphe-
noid suture are easily seen,
between these two, and just
back of the intersphenoid su-
ture, lies a small emissary
vein from the bone, probably
marking the obliterated crani-
opharyngeal canal, this small
persistently oozing point will
at first be an excellent land-
mark, for I have never failed
to observe it in any animal
operated upon. If the pontine
region is to be attacked, the
mucoperiosteal incision is
more posterior, and the mus-
cles are freed laterally from
the porous parabullar ridge.

The basal plate of the
skull is attacked with a 3 mm
dental burr, outer table, dip-
loe, and inner table being re-
moved, the intervening plate
at the sella is about 4 mm
thick in the average dog, in
the midline back of the occi-
pitosphe-
noid suture it is usu-
ally only 2.5 mm thick, but
laterally near the bullæ it may
be 10-11 mm thick, and it
may be necessary to use
gouge and mallet in cleaning
out the extreme posterolateral
corner. Since the dural venous
sinuses immediately underlie
the inner table, good control
of the burr is necessary. The
final paper-thin flakes of inner
table may be removed with
probe, curette, or forceps. The
nasal border of the perfora-
tion should be shelved toward

the operator, to afford more working room and a better view. An injured venous sinus may be controlled by packing, suction, and ultimate manoeuvring of a piece of muscle over the tear, but prevention is to be preferred to the tedious minutes necessary for this hæmo-
stasis. The field is kept clean by sluicing with saline. Shining dimly through the exposed
dura the edges of the venous sinuses can be seen and gross subjacent structure identified.

When hæmostasis is absolute, the dura is opened with dural hook and dural knife

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In hypophysectomies it is well to remember that in the dog and cat the lateral cavernous sinuses do not meet anteriorly though they do posteriorly, and that therefore the incision should err in length rostrad rather than caudad. The reverse is true for pontine exposures in the neighborhood of the inferior petrosal sinus, as reference to Figures 3 and 5 will show. In making these posterior incisions care should be taken not to injure the basilar artery and its branches, which lie immediately under the dura within the pia-arachnoid. It is frequently necessary to open the arachnoid to identify completely the point of origin of a nerve, for those in the posterior fossa often have a 4 to 10 mm extramedullary course before becoming invested with arachnoid sheath. The preferred incision in the dura is linear, but if necessary it can be made triangular or stellate. If operative procedures through the dural opening extend beyond thirty to forty-five minutes the danger of meningitis is appreciably increased.

The goal accomplished the bony defect is packed with a moist mercuriochrome patte which is withdrawn just before the final suture is placed in the mucoperiosteum. The intact mucoperiosteum is closed completely with three interrupted sutures of double-zero plain catgut, using the smallest size ($\frac{3}{8}$ -inch curve) needles. The soft palate is closed in three layers with interrupted sutures of black silk, the nasal tampon being withdrawn just before completion of the first layer. The animal is again gavaged with 0.1 gm/kg hexamethylenamine, and removed to a warmed, blanketed cage. The

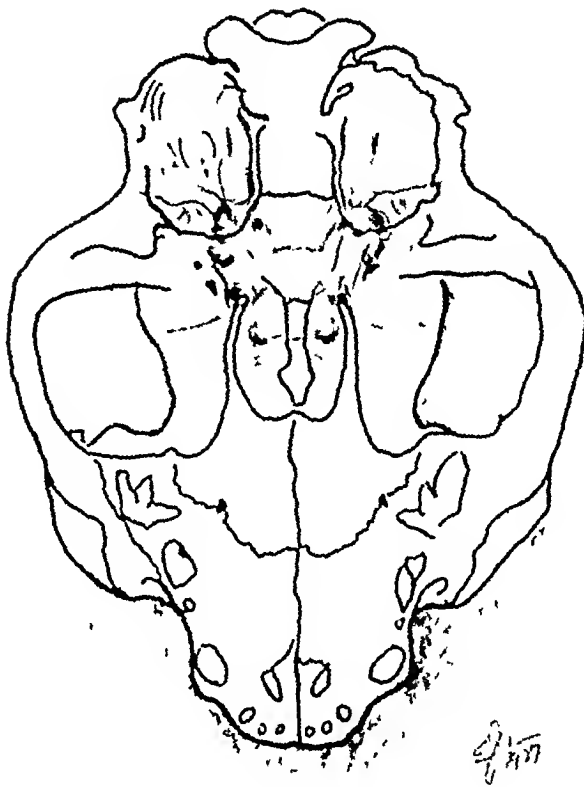


FIG 6—Composite view of inferior and superior surfaces of the basic plate of the feline skull. The inferior (extracranial) surface is shown in outline, the superior (intracranial) surface is in half tone. In operating these relations must be constantly in mind.

duration of the average transbuccal operation is about two and one-quarter hours, of which probably three-fifths is used for exposure, a fifth for the operation proper, and a fifth for closure.

The points of this operation are (1) an anatomically controlled approach to structures of the base of the brain through a field of potential extreme vascularity (2) conservation and exact reapproximation of the nasopharyngeal mucoperiosteum, which interposes an intact physiological membrane as a bar to infection of the meninges (3) avoidance of post-operative nasal discharge, favoring infection, by light tamponage of choanae (4) anatomical closure of soft palate in layers, conducive to proper healing and thereby avoiding improper swallowing mechanism through dehiscence of the palatal wound, with the danger of late post-operative aspiration pneumonias. It is not good surgical theory to plug the bony defect with dental compound or bone wax, an unintentional illustration of the extent of foreign body reaction which such material may cause is given in the first necropsy report below. Necropsy report of one of the two fatal cases is also given, and finally the findings three months after a successful operation.

CASE I—Dog D-11, 22 kg American bull. Transbuccal section of left sixth nerve

2 mm from pontine origin, December 24, 1926 "As final part of bone plate was being burred away, drill caught in dura at posterior border of opening and made a 1.5 mm triangular tear in dural wall of inferior petrosal sinus. A fair amount of bone wax was placed between the bone and dura posteriorly before relations were clear. When source was discovered, stopped bleeding with muscle, and dug out as much bone wax as possible, but think a fair amount still remains." Uneventful recovery, dog frisky and symptom-free the following day. *Necropsy*, February 12, 1927 "Left crus tightly adherent to petrosal ridge near midline, dissected free carefully. Proved to be largely due to a fibrous foreign-body reaction around a pellet of bone wax. The left inferior petrosal sinus was completely plugged with bone wax, encapsulated by a neo-membrane, and this extended forward on the left to the posterior leg of the circular sinus, where pressure absorption of the cancellous bone had made a deep erosion in the basal plate of the skull, so that only 1.0-1.5 mm of porous bone remained above the nasopharyngeal mucosa, this was about five or six mm diameter, and was at first taken for a misplaced operative bony opening, but lateral dissections behind the petrosal ridge showed the operative bony defect almost completely closed and reossified except for a small smooth-edged opening about 2 mm diameter (original opening 10 x 6 mm)."

CASE II—Dog D-12, 13 kg Collie Transbuccal section of left sixth nerve, November 30, 1926, post-operative meningitis "Opening was placed too far anteriorly, and on attempting to open dura, the petrosal sinus was encountered repeatedly. hæmostasis quite difficult, but maintained. After two and three-quarter hours a bit of bone was taken with straight rongeurs, more posteriorly and laterally, undermining the stylomastoid tubercle. Dural incision was made here and ultimately proved to be over the left middle of the pons, not as far laterally as usual. On depressing the brainstem to the right, the sixth nerve was seen. A long right-angled dural hook knife was inserted under it in an attempt made to cut it with right-angled scissors, which failed. The nerve was therefore partially cut through and partially avulsed with dural hook knife. Nasopharyngeal mucoperiosteum closed intact except for 1.5 mm tear on left anteriorly. Duration four and one-half hours." The muscle used for hæmostasis was biventer, taken about one and one-half hours after incision of the mucoperiosteum. The dog recovered from anaesthetic, was erratic, thirsty, and later vomited, eighteen hours after operation it became unconscious, head retracted, neck stiff, legs straight out, had Biot's breathing with hypernoea, exitus four hours later. *Necropsy*, December 2, 1926. 'Nasopharyngeal mucosa over occipital bone has stitches intact, good approximation. a few small plaques of fibrin 2 x 3/4 mm in size are over the incision. On removing stitches a small amount of thin slightly glairy turbid fluid is found in bony operative defect, and a 2 mm fungus cerebri. When calvarium, hemispheres, and cerebellum are removed, a thin sheet of clot is found about and below the cerebellum at the right side of the incisura tentorii, extending caudad down to vagal roots, across ventral aspect of medulla, and a short distance anteriorly on the left. The surface of the cerebrum is slightly reddened and there are a few whitish streaks under the pia in the frontal sagittal convolutions. the pia is everywhere slightly injected, and the cerebrospinal fluid in the lateral ventricles is slightly turbid."

CASE III—Dog E-7, 26 kg Dane mongrel Transbuccal hypophysectomy May 4, 1927 "Suture between anterior and posterior ossa sphenoida easily identified, a 4 mm opening just posterior to this drilled in midline, edges of opening made perpendicular with small curette. Circular sinus seen in left lateral border and avoided. Dural base of sella incised stellately with right angled dural hook knife. Anterior lobe pouted into defect and was removed in two bites with curette forceps, no bleeding, sucker constantly, moderate amount of cerebrospinal fluid. Posterior hypophysial lobe seen still attached posteriorly, and was curetted out piecemeal, tenaciously adherent at dural attachment near clinoids. Sella seen by direct inspection to be entirely dry and empty. Probably 2 to 3 cc blood lost in removal." Dog used repeatedly for titration of cytotoxic substance in blood dialysate. *Necropsy*, August 10, 1927. The peri-infundibular

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region was loosely adherent to the dura by filmy wisps, the dura was "adherent deeply into the pit of the healed bony operative excavation" which was "so firm that a probe could not pierce it, with considerable force"

SUMMARY

A description of a relatively avascular experimental transbuccal approach to the base of the brain of carnivora is given, which necessarily avoids damage to contiguous neurological structures, and which has a considerably lower mortality rate than any procedure heretofore described approaching this region (Aschner, 29 per cent, Dandy and Reichert, 16 per cent, present operation, 11 per cent, the final twelve operations of this series having negligible morbidity and being without a single fatality)

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PLASTIC SURGERY ABOUT THE EYES.*

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THIS paper is intended to present several types of conditions occurring about the eye which may be treated by the general surgeon. This paper is further circumscribed in that it does not pretend to be a consideration of all the many and varied conditions it might be made to include.

Not an inconsiderable proportion of surgery about the eye consists of removing conspicuous scars and replacing them with minimum scars (Figs 1, 2 and 3). All scar tissue must be excised widely until good skin edges can be brought together without tension and in slight eversion, undercutting the edges when necessary. Having carried out the proper technic, the minimum scar will result. What the minimum scar for any particular patient is, then depends on the healing powers of that patient.

In all plastic surgery, and in fact in all surgery, the tissues must be treated kindly. Traumatism of the edges which are to be brought together make impossible the obtaining of the minimum scar. I have found it unnecessary to use forceps of any kind on tissue which is to be left in any operation, except to pick up vessels.

When the edges of wounds are crushed with hæmostats or are picked up with tissue forceps, mouse-toothed or otherwise, there results a definite injury. Every scar is the tombstone of an injury, therefore the necessity of avoiding even slight traumatisms and developing a technic which will put this into practice.

When it is necessary to pull tissues about it had best be done from the under-surface with sharp hooks. When these are insufficient, pierce the tissue back from the edge with a fine-pointed instrument, as a hook or towel-clamp, rather than apply crushing instruments.

The next most important principle in plastic surgery, second only to treat the tissues kindly, is, do not merely approximate wound edges, bring them into exact apposition. In the approximation of wound edges they are brought together approximately, nearly, but when the edges are brought into exact apposition, they are placed in the best possible position for healing. Every surgeon has noticed that portions of wounds heal quicker and with nicer scars than other parts of the same wounds. The edges which heal most rapidly and which produce the least scar are those which have been placed in exact apposition. With the edges in exact apposition there are no gaps to be bridged and the minimum scar formation is required to hold the edges together. Wound edges can be held in exact apposition by the careful placing of the necessary number of sutures. Use suture material and needles as fine

* Read before the King County Medical Society, Seattle, Wash., March 19, 1928

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FIG 1—A scar resulting from healing of a wound without the underlying tissues being brought together



FIG 2—A scar extending from the forehead down the face to under the chin. Leveled and resutured, giving an invisible scar



FIG 3—The result of a dynamite explosion. Skin deformity requires correction and the eyelids and eye socket must also be rebuilt



FIG 4—Shows result of the absorption of fat from about the upper and lower lids following loss of an eye. Corrected by transplantation of fat from thigh

as the nature of the work will allow. The needle should be inserted at a right angle to the surface so as to produce a minimum destruction of cells. Bring the skin edges together to appose, not only the skin itself, but the tissues directly underlying.

There must never be tension on the stitches holding the edges together. Tension must be relieved. This may be done by uniting the subcutaneous tissues with catgut, or by figure-of-eight sutures of horsehair so that the deeper loop brings the edges together.

It is often necessary to relieve tension by placing deep mattress sutures of silkworm gut beyond the line of union. These may be tied over buttons inverted. When buttons are applied in the ordinary manner the maximum pressure occurs in the area directly surrounding the suture, but when properly selected buttons are applied, upside down, this is not the case. The buttons used are the ordinary bone underwear buttons, free from sharp edges, and having a depression immediately surrounding and including the stitch-holes. When these are applied in this manner the maximum pressure is at a little distance from the stitch-holes. There really occurs a protrusion about the stitches so that when the sutures are removed the conical projections retract to the level of the surrounding skin. It is not necessary to tie tension sutures real tight. They should be tight enough to just relieve the tension.

It should be the aim to produce in every surgical procedure not only a minimum scar, but an artistically healed wound. It is surprising how small the scars may be made and how difficult they may be to find when the technic gives due consideration to the various points involved. During healing wounds must be held quiet, for otherwise the pulling and movement of the edges on each other will produce larger scars. Keloids are the result of tension on the wound edges, plus movement, plus the healing powers of the patient. The formation of these disfiguring scars may be minimized by attention to proper details. While scars are usually invisible no patient should be told that they will not be the one to have a larger scar, due to conditions within the patient himself.

An otherwise nice-appearing scar may be disfigured by cross-marks, the result of leaving sutures in too long. Sutures are placed for the purpose of holding the tissues together until healing has taken place, and as soon as this is accomplished, they had better be removed carefully. In a recent paper the author discussed the production of the minimum scar in detail †

Practically all operations in plastic surgery may be performed under local anæsthesia, using usually one per cent procaine (novocaine) with five minims adrenalin solution per ounce. The youngest patient on whom I have used it was a girl of four years, and the oldest, a man of eighty. Talking to patients more or less continuously during all operative procedures and encour-

† The Minimum Scar Bettman, A. G., Medical Sentinel, Portland, Oregon, April, 1926

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FIG 5—Condition when I saw him after he had undergone many operations elsewhere. Scar below eye replaced by Wolf graft. Scar at outer canthus excised and palpebral fissure made smaller.



FIG 6—Notches in upper lid corrected. Tissue excised within orbit to overcome ectropion. Portion of temporal muscle grafted into lower lid to give motion. Lower eyelid thinned. All work done on lids through old scars.



FIG 7—Disfiguring wrinkles on lower eyelids



FIG 8—Wrinkles removed by excision. Scars invisible

aging them to reply allays their fears and gains their cooperation. Occasionally a patient drops off to sleep during the operation.

Thirty minutes previous to the beginning of the operation, the patient is given a hypodermic of one-sixth or one-fourth grain of morphine and one-one hundred and fiftieth grain of atropine, and by mouth one and one-half grains isoamylethyl barbituric acid (amytal). The amytal is given because less anæsthetic is required and the patient is not nervous, but most important of all is the property the barbitals possess of blocking the toxic effects of the local anæsthetic, also amytal acts very quickly.

Having assured the patient that the operation will be done painlessly always announce before the needle is inserted the first time that it will be felt else the confidence of the patient may be lost.

The loss of an eye with its unfortunate deformities, is a serious handicap to any patient. When an eye is lost as the result of disease or injury, there may or may not be injury to the surrounding soft parts (Fig 3). When an eye must be sacrificed it is important, in order to obtain a subsequent good appearance in the wearing of an artificial eye, that the muscles be properly taken care of. They must be sutured to those which are opposite to them, anatomically and functionally, across the wound and not to those adjacent. The internal rectus must be sutured to the external rectus, and the superior rectus to the inferior rectus, irrespective to the type of operation otherwise. It is only when this is done that the maximum amount of mobility of the artificial eye is obtained. Care should also be taken to provide a sufficiently large cavity with depth and height enough to hold the prothesis in position.

As the result of the loss of an eye through injury, it may happen that there has been destruction of large amounts of mucous membrane and other tissues or that the mucous membrane is so lacerated that when healing has taken place, the cavity is either too small to hold an artificial eye or is badly shaped (Figs 4, 5). In the primary suturing of such an eye socket, it is necessary to bring the edges accurately together, for here, as elsewhere, surfaces not covered by epithelium heal by scar formation and contractures. When a contracted socket is present it is necessary that it be reconstructed. In reconditioning a socket, the tissues underlying the mucous membrane usually must be removed over a wide area, superiorly, inferiorly and laterally and the mucous membrane carefully sutured. However, this may not be sufficient, for, if allowed to heal thus, the original inadequate cavity may recur. To prevent such an unfortunate result, hold the mucous membrane up and down and out against the depths of the socket. This is accomplished by a very simple method. Having prepared the cavity and sutured the mucous membrane to give the maximum relaxation, a piece of dental modelling wax is molded to fit the cavity and being sure that it fits well into the recesses, the eyelids are sutured together over it. This model, in addition to forcing the mucous membrane against the walls of the cavity, allows the eyelids to be held in an over-corrected position until healing has taken place.

It sometimes happens that there is not available sufficient mucous mem-

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FIG 9—Shallow deformed eye socket



FIG 10—Artificial eye in place. The œdema of the lids had not entirely subsided when picture was taken



FIG 11—Heavy disfiguring pouches under eyes



FIG 12—After excision of crescent shaped piece of skin from lower lids

brane to line the proper-sized socket. It is then necessary to provide epithelial lining for that portion which is deficient. This may be done by means of a Thiersch graft, laid over and held in place by a model of dental wax, a stent. In cutting such a graft a suitable razor is imperative ‡.

There is no reason why mucous membrane obtained from the prepuce cannot be used to supply such a deficiency. The writer has not had an opportunity to use this source of supply for this purpose, but has used it to stent-graft mucous membrane into the mouth to restore the sulcus between the lower lip and the inferior maxilla below the teeth with an excellent result.

A deformity which produces more mental effect than it seems to warrant and which is present in so many patients who have suffered the loss of an eye, is the absorption of the supra- and infra-orbital fat (Fig 4). Patients seem to have a greater aversion for this hollow-eyed, cadaverous appearance than for many other major defects. This unsightly condition can be corrected by the transplantation of fat from either the abdomen or upper part of the thigh. I have used both but prefer that over the fascia lata, as it is firmer, readily obtained, and the resulting scar cannot be mistaken for evidence of a previous abdominal operation.

Incise the skin away from the position that the fat is to occupy and with a long-bladed, narrow, rather small scissors, make a tunnel that maps out the entire area to be filled. A piece of fat is prepared of such size that when placed in position the defect will be somewhat over-corrected. The wound free from oozing, is closed carefully and a pressure dressing applied. After healing has taken place, there is absorption of a portion of the fat, usually about one-third, which fact must be taken into consideration. Fat may also be used to fill defects in the frontal region, resulting from operations on the frontal sinuses or from loss of tissue through trauma or otherwise.

Transplanting a muscle to give motion to a paralyzed or muscleless eyelid is an interesting procedure. The temporal muscle is used, detaching above a strip one-fourth inch wide, leaving it attached below and suturing the free end to the eyelid, after passing it through a subcutaneous tunnel.

Wrinkles, bags and folds, the superabundance of skin of the upper and lower eyelids, which give the appearance of age, or worse, of premature age (Figs 7, 8, 11 and 12) may require attention. Such evidences of increasing age, of course, do not make their appearance suddenly, yet there comes a time when the realization of the disfigurement is brought home to the patient in such a way that the removal of the circumstantial evidence of beginning antiquity is desired. It is necessary often to correct also the appearance of the face, neck and chin in order to brush back the heavy hand of time.

The desire to have wrinkles about the eyes removed, alone, without giving consideration to the rest of the face, in my experience, has been more fre-

‡ A New Thiersch Graft Razor Bettman, A. G., Jour. A. M. A., Chicago, Aug 6, 1927, vol. LXXXV, p. 451

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FIG 13—Photograph of wax model. Loss of eye, ectropion of lower lid, and loss of portion of nasal bones. Shot for a deer.



FIG 14—Condition following correction of eyelid and nasal deformities. Prosthesis in place.



FIG 15—Fell in fireplace when one year old, now over sixteen.



FIG 16—Condition of eyelid after pad of gauze had held it up a few days. Lips after first operation.

quently requested by men than by women. Women give concern to the face and neck first. It seems as though the wrinkles and lines about the face of a man produce less psychological reaction than do those about the eyes. I have noted also that men are more jealous of the secret that they have had these corrugations of age removed than are women. The operation is frequently done on men the first day of their vacations. Healing has taken place usually by the fourth day. Add ten days more for vacation, and he returns to his associates, remarkably younger looking. The credit for his rested-up, more youthful and better appearance being given to the wonderful sea breezes or invigorating mountain air, as the case may be. The scars are so small as to be imperceptible.

When a patient applies for relief of baggy eyelids with wrinkles and overfullness the surgeon must fix in his mind the exact condition to be corrected. How much tissue to remove is always an interesting problem.

The operation will now be described, no consideration being given to conditions which may, or may not, have been corrected in other parts of the face.

With a pair of scissors, curved on the flap, and which cut perfectly, or with a very sharp knife, preferably of the replaceable blade type, the desired amount of tissue is removed. When the knife is used the crescent-shaped area of skin is outlined with it and excised. I prefer the scissors.

Note the amount of skin to be removed by picking up the lid covering, when the eyes are gently closed. The skin well within this area is grasped by tissue forceps and pulled away from the lid. Then with the scissors, the skin included in the forceps is cut away. When too little has been removed it is a simple matter to enlarge the excision. Sufficient should be cut away so that when healing has taken place the closed lid will have just enough tension that had any more been removed it would have been too much. The excision having been completed very fine horsehair on small needles is used for interrupted sutures. The stitches are inserted quite near the edges of the wound, care being taken here as elsewhere to bring the edges into exact apposition.

Oftentimes, in order to produce the maximum benefit, it is necessary to extend either the upper or the lower incision, depending upon the condition, beyond the outer angle of the eye toward the temple and excise there an ellipse of skin of such length and breadth that the so-called crows-feet are removed.

Removal of the right amount of skin, the careful suturing of the wound edges producing invisible scars, and the resulting absence of the wrinkled and otherwise disfiguring eyelids, leaves the normal fullness of the eye skin. Of course, it is necessary not only to carry out the same procedure on the opposite side but to carry it out to the same extent. No dressings are used. Some of the stitches are usually taken out after twenty-four hours, and in most cases all but the centre one after forty-eight hours, this last being removed the following day. There is little or no redness, the amount

of scar is very small, and the patient appreciates the change in appearance. Oftentimes only the upper or only the lower lids require correction.

The surgical removal of those yellowish, disfiguring areas, xanthoma, is accomplished in this same way, making such modifications in the technique as the condition indicates. These may also be removed with saturated solution of trichloroacetic acid, but healing is very much slower, a matter of weeks instead of days.

In suturing wounds of the soft structures about the eyes it should be the aim to restore the tissues as accurately as possible to their original positions, using a sufficient number of sutures carefully applied to accomplish this purpose. Many times following the healing of such a wound it will be found that the upper cheek tissue is divided by the scar, producing a very disfiguring effect. This might have been obviated, had the deeper tissues been sutured as well as the skin. In lacerations extending into the subcutaneous tissues, it is necessary to bring these tissues together also. Fine catgut may be used, but this is usually unnecessary when deeper structures are not involved if the horsehair is inserted as figure-of-eight stitches. This stitch is a little slower to place but brings the underlying tissue and the skin together often before the knot is tied.

In cases where there has been infection there is more likely to result a pouching effect which is due to the shutting off of the lymphatic drainage by the scar. This drainage may be reestablished by excising the scar septum, suturing carefully and placing two or more silk threads, impregnated with Bipp, so that they extend from well above the septum to well below it. They are cut off close to the surface and their ends made to retract well below the full thickness of the skin at both ends.

This method was carried out for a young man who had a very disfiguring lesion of this type. The scar was excised, the wound carefully sutured, and the silk inserted. After several months the threads worked toward the surface at their lower extremities and were removed, but the amount of scar is so small and the pouching has so far disappeared that today an observer would have to search for the one and would not be able to find the other. This man had other conditions which complicated the case and which were all corrected to his entire satisfaction.

It is perhaps rare for a patient who has received a serious injury about the eye to present himself with only one surgical problem. Usually there are at least scars to be removed in addition to the other deformities. Multiple lesions are the rule following cutting injuries about the eye.

No rule can be laid down applicable for the correction of all cases of ectropion and entropion. Many of these conditions are difficult to handle. When there is loss of the eye the eyelid condition often can be corrected at the time the socket is repaired (Figs 13 and 14). Moderate ectropion may be corrected by suturing a "V" of the skin as a "Y", or by excision and suture. This gives very good results in the small percentage of cases to which it is applicable, the scar being negligible. Shortening the mucous

membrane surface may be indicated. Sometimes the shortening of the lid margin by excising a "V" the full thickness of the lid will give the result. There are many and varied operations recommended, each applicable to a particular defect and designed by the originating surgeon for the case at hand.

When the tissues are insufficient to allow the lid to be raised it is necessary to transplant skin from the other lid of the same side, or from the temple or elsewhere. This may also be necessary following the removal of disfiguring moles, birthmarks, epitheliomas, and other lesions. On occasions entire eyelids must be provided.

When ectropion is so marked that sufficient tissue cannot be readily obtained by the means just mentioned, another method must be used. The case of a young woman will be described. When one year old this girl fell into the fireplace while strapped in a high-chair. Her face was badly burned. Probably the most disfiguring conditions about the eyes are the result of burns (Figs 15 and 16).

In the following case an unsuccessful attempt at correction had been made by another surgeon previous to my seeing her. When I saw her she was past sixteen years of age. Her lower left eyelid was in extreme ectropion. By extreme is meant that the lid was pulled down on the face as far as was possible, the entire mucous membrane being exposed, the ciliated edge lying on the cheek an inch and a quarter below its normal position and firmly held there. The mucous membrane was the seat of a chronic inflammation. The front of the eye was exposed. The skin of the cheek below the attachment of the eyelid was pulled up and was badly scarred. In addition the left halves of both lips were inside the mouth and held there by contracted scars. The problem regarding the lid was to raise it to its normal position and keep it there. Skin was supplied by means of a full thickness graft held in place by a stent.

An incision was made through the scar of the cheek below the lid margin, removing all scar tissue, and freeing the lid over its entirety. The lid was then held in the position which it occupied before the beginning of the operation and a model of the cavity thus formed was made of dental modelling wax. From the skin of the inner side of the arm a section was cut of such size that it would entirely cover the model. This graft which included the full thickness of skin, devoid of all fat, was applied to the model, surface side against the wax, and enough sutures placed in its open sides to prevent the model slipping out. The model, thus covered by skin which was drawn taut, was placed in the cavity between the eyelid and the cheek and sutured in place, care being taken to fit it well up against the lower fornix.

A suture was passed through the skin of the lower lid, through both layers of skin of the graft, through the lower layer of wound and tied. Such stitches were continued across the entire length of the wound and the original sutures removed. At the end of the operation, due to the presence of the skin-covered model, the eyelid was a little fuller than before.

On the ninth day the stitches were carefully removed. The eyelid was now free, covered by its mucous membrane above and by skin below, which skin extended down on the cheek. The graft had taken perfectly. The eyelid was then raised up against the eye-ball and a pad of gauze applied. Later some adjustments were necessary, due to the long years of stretching having made the lid margin too long to hug the eye-ball as it normally should. The result was very pleasing to the young lady and the smile on her face indicated the change, not only in her face, but in her mental attitude.

PLASTIC SURGERY ABOUT THE EYES

The skin of the eyelids is different from that of other parts of the body, in that it is very thin. The only skin of a similar type is on the prepuce, which source of supply might be used to good advantage to fill deficiencies of the eyelid.

Interesting operations are those of restoring the loss of eyebrows and eyelashes. An eyebrow may be restored by transplanting a portion of the remaining brow or a portion of the opposite one, or by means of a free or pedicled graft of hair-bearing skin from the scalp, care being taken to see that the hair will be turned in the proper direction.

Tattooing eyelashes will not take the place of transplanting hair-bearing skin but is useful where the lashes are few and far apart.

To make the eyes larger, canthoplasty, the incision is made from the outer canthus, outwardly, and the edges of the skin and mucous membrane on each side of the incision are sutured accurately together. A very small incision, one-sixteenth to one-tenth inch, enlarges the palpebral slit quite enough.

A condition which is very difficult to restore is that of the distortion of the inner canthus. This is due chiefly to the fact that in this region the tissues are quite loosely attached to the surrounding osseous structures. When the entire inner canthus is too low or when the inner end of the lower lid is too low, the effect is bad. There are a number of methods for making this correction, but a good result is difficult to obtain. It seems to be one of those little things that require strategic handling. The best result in some cases is accomplished by making a linear incision or an ellipse is excised at the nasal side of the canthus of the proper length and location, and sutured so as to bring the opposite ends of the wound together, placing the sutures deeply above to bring the lower angle up.

Contractions following burns may cause deformity closing the lids which will require an entirely different method of treatment.

When two years old, L. W. was burned by falling so that his eyelid came in contact with a hot stove-door handle. The burn extended from well up on the superior lid to almost the lower border of the ala. The cornea was seared, the inner half of the pupil was opaque, and he had developed compensatory strabismus. The contraction of the skin scar pulled the upper lid down, uniting it to the lower lid and drawing the distorted inner canthus outwardly. The lids were pulled a considerable distance away from the eyeball at the inner canthus. The boy was at this time six years old. He had a distorted appearance and was beginning to realize his deformity. He was unable to see with the impaired eye because of the position of the lids. The first operation removed the scar from the inner canthus down along the nose. He was now able to see, the lids being out of the line of vision. At the second operation scar was removed to a considerable depth and the lids sutured close up against the eyeball. The boy's condition at this time was quite good except that the distance from the nose to the inner canthus was still somewhat greater than on the other side. The inner canthus was later brought nearer its normal position.

Patients appear not infrequently for the removal of disfiguring masses of paraffin from about the eyes. The simplicity of injecting paraffin makes it

appeal to those who are not properly qualified for other types of work. The immediate result is very good and the patient is satisfied, but after a number of years connective tissue growth is stimulated and the mass enlarges, producing great disfigurement.

This does not happen, fortunately, in every case but is sufficiently frequent to make its use unjustifiable. In addition to the masses appearing in unnatural places the skin over the injection often becomes red.

The removal of paraffin is a difficult procedure. The patient expects that the operated area will be smooth and devoid of irregularities. This usually can be accomplished but no surgeon would make such a promise to a patient.

Although it has not been mentioned specifically you have noted that many cases have required repeated operations for the production of the maximum correction. To attempt the complete operation at one step would not give the best result. It is better to attempt one step and accomplish it than to try too much and not be successful. Stage operations produce results not attainable otherwise and many steps may be required. Under local anæsthesia this can be accomplished.

CANCER OF THE TONGUE AND FLOOR OF THE MOUTH^{*}

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WE ARE presenting an analysis of the 164 cases of carcinoma of the tongue and floor of the mouth, who were treated on our Service at the Radiologic Department of the Philadelphia General Hospital from 1922 to 1928.

When we consider the incidence of carcinoma of the tongue and floor of the mouth according to race, sex and age, we find there were eleven negroes or 7.9 per cent, and seven females or 4.2 per cent.

The youngest patient was twenty-eight years of age and the oldest was eighty-six years. Grouped in ten year classes, we have the following:

Between the ages of 20 and 30 there was	1	or	6%
Between the ages of 30 and 40 there were	2	or	1.2%
Between the ages of 40 and 50 there were	22	or	13.4%
Between the ages of 50 and 60 there were	51	or	31%
Between the ages of 60 and 70 there were	51	or	31%
Between the ages of 70 and 80 there were	21	or	12.8%
Between the ages of 80 and 86 there were	2	or	1.2%
Undetermined there were	14	or	9.4%

It is to be noted that the ages from fifty to seventy includes 62 per cent of the patients.

In studying the duration of the disease in our series from onset to death, we notice very vast differences. It was very evident from examination that some of these patients had been suffering from malignancy of the mouth for a long time before they were aware of the fact that any abnormalities existed, as they were in an advanced stage before consulting a physician. Some gave a history of conditions extending over many years which were probably pre-cancerous lesions and had degenerated into cancer.

There were 48 cases who lived less than 1 year
There were 39 cases who lived from 1 to 1½ years
There were 7 cases who lived under 2 years
There were 8 cases who lived under 3 years
There were 6 cases who lived under 4 years
There was 1 case who lived under 5 years
There were 2 cases who lived under 6 years
There was 1 case who lived under 7 years
There were 2 cases who lived under 8 years
There was 1 case who lived under 12 years
There was 1 case who lived under 16 years
There were 48 cases who lived duration not determined

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and in a third a typically scarred kidney of chronic interstitial nephritis was seen. All died of uremia.

The organ was hypertrophic in three cases and apparently normal in three. Marked dilatation and infection of the ureter and kidney pelvis was found in two instances. In the first, an adult, there was no obstruction, in the second, an infant of one year, a dense ureteral stricture was present 1 cm above the bladder. The former died following an operation for carcinoma of the breast, the infant died of uremia. Ectopia of the solitary kidney has been noted, the kidney having been found in the pelvis in some cases, in the abdominal cavity in others. In one of our cases, the kidney was in the midline, the ureter coursing down and emptying into the bladder near the midline. In another, a child of six years observed clinically, the single kidney was freely movable about the right lower quadrant and showed moderate hydronephrosis, ureteral dilatation and infection. A predisposition to calculus formation in solitary kidneys has also been observed. In our series no stones were found.

SUMMARY

Although unilateral renal agenesis occurs but once in approximately 1,600 individuals, the condition is not infrequently encountered by urologists. A left-sided incidental preponderance has been noted. As a rule there is no suggestion of the lesion until urinary signs and symptoms arising from the diseased solitary kidney instigate a complete urological examination. The condition of the solitary kidney merits our greatest concern. Often palliative measures only can be employed because of the advanced renal injury. Of the nine cases here reported and proven by autopsy to have but one kidney, three died of renal failure.

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KIDNEY RESECTION

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RECENT literature on renal surgery indicates that surgeons are recognizing the value of conservative surgical procedures on the kidney

In the early days of renal surgery nephrectomy was fraught with much uncertainty and high mortality, and only rarely done. When it was found that incisions might freely be made in the kidney substance and that they healed readily, resection or partial nephrectomy was attempted. This operation showed a much lower mortality than nephrectomy and consequently, for a short period of time, it was considered a more desirable surgical procedure. The fragment of kidney not removed usually healed promptly and preserved a portion of functioning tissue.

Historical—As early as 1886, only a few years after nephrectomy had become an established operation, Czerny¹ removed a portion of a kidney following trauma. This was really an emergency procedure, but the following year he did the first deliberate resection of a kidney, removing the lower pole, which contained angio-sarcoma, in 1889 he carried out three further resections. At about the same time Kummell² also resected a segment of a kidney for stone and abscess.

Von Schmieden,³ in 1901, collected reports of thirty-four cases of resection in 2,100 kidney operations. In 1,118 total nephrectomies there was a mortality of 27 per cent. Only four (11.8 per cent) of the patients in the thirty-four partial nephrectomy cases died. Moynihan,⁴ in 1902, reported two cases of resection of the kidney, one for cyst and the other a case of excision of half a kidney for myxosarcoma. In both his cases a wedge of kidney substance was removed and the wound was closed by interrupted catgut sutures. Henry Morris⁵ reported a case in which one kidney was removed for tuberculosis, later one-third of the remaining kidney was excised. The patient was well five years after the latter operation. A similar case was reported by Papin.⁶

Berti⁷ collected reports of 112 cases of resection of the kidney from the literature up to 1921. Eighty-six recovered and eleven died. The outcome was unknown in fourteen. A total nephrectomy was necessary later in seven cases and a fistula persisted in five. The total 112 cases included five of cancer, with two cures, fifteen of tuberculosis, with seven cures, fifteen of simple hydronephrosis, with fourteen cures, and eighteen of horse-shoe kidney, with twelve cures.

How Much Kidney Substance Is Necessary to Support Life?—The work of Tuffier⁸ thirty years ago, and that of Bobroff⁹ later, demonstrated that life could be supported on a very small portion of a normal kidney. Tuffier.

in his experimental work, did a total unilateral nephrectomy plus more or less extensive resections of the other kidney in an endeavor to find exactly the quantity of normal kidney tissue necessary for the maintenance of life. He found that there was a definite regeneration of tissues in the remaining segment if the portion allowed to remain was sound, otherwise not. Tuffier's work formed the basis of his later "morcellement" nephrectomy. Paoli¹⁰ showed by his experiments that if one-half of one kidney was excised, and, after an interval, the whole of the opposite kidney removed, the remaining half sufficed to maintain life. Very probably in these cases, where only a small portion of renal tissue remains and where there is a demand for an increased amount, regeneration takes place. Stoerk¹¹ described two methods of new formation of renal parenchyma, one by the elongation and winding around of normally present tubules, the other by ramifications due to new budding. Simpson¹² demonstrated that the epithelium of the tubule is capable of proliferation and that small losses in the tubular epithelium are quickly replaced. When there is a demand for compensatory hypertrophy in the remaining renal tissue its beginning is indicated as early as the third day.

The Sequelæ of Kidney Resections—Results were not completely satisfactory following partial nephrectomy. Owing to difficulty of approach and insufficiency of drainage, fistulæ formed and occasionally secondary total nephrectomies were required, only 58 per cent of von Schmieden's³ thirty-four collected cases healed. Besides, better results were being obtained with total nephrectomy, the surgical technic for the removal of kidneys was more satisfactory and the operative mortality was distinctly lower. Nephrectomy became the operation of choice in malignant, tubercular and other infectious conditions of the kidney, and for a period of twenty years virtually nothing was reported concerning partial nephrectomy. In the rare cases that partial nephrectomy was performed, it was usually, but not always, done for various non-malignant, non-infective conditions such as cysts, large, benign tumors, and painful or distorting renal anomalies.

With the improvements that have been made in recent years more satisfactory methods of approach are being employed and external incisions, such as the postero-lateral, are made that permit visualization of the entire field of the operation. Consequently, as it is sound surgical practice not to remove any tissue capable of functioning, the more highly technical conservative procedures are again being attempted and, as shown by Judd,¹³ Hinman,¹⁴ and Caulk,¹⁵ the trend of modern renal surgery is toward conservation.

Judd¹³ considers that localized infections are amenable to resection. Although the surgical technic is not yet sufficiently perfect to prevent the formation of sinuses from calices or pelvis, yet these, when they occur, heal promptly. The important thing is that the sound stump of kidney left behind must be assured of an adequate blood supply before the vessels of the diseased part are clamped. After suture the area of resection is covered by a portion of the fatty capsule.

The experimental work of Perlmann and Kairis¹⁶ showed that simultaneous resection of both kidneys, or simultaneous nephrectomy and resection, were the most fatal types of procedures, in non-simultaneous operations on both kidneys the results were good

The work of Hinman¹⁴ has shown us that if one kidney is doing all the work, it would be inadvisable to conserve a portion of the opposite apparently functionless kidney. The conserved fragment would have no stimulus to function and might even later require removal or at best become completely atrophied

Illustrative Case—The following case is one in which both kidneys were diseased. It was necessary to remove a portion of one kidney containing stone, resection was done, conserving a fragment of kidney which, after operation, was equal in functional value to the non-operated kidney

A woman, aged twenty-nine, married and having one child aged two, came for relief of pyuria and pain in the region of the left kidney. At sixteen years of age, following three attacks of abdominal pain, her appendix had been removed and at the age of twenty-six a plastic operation was done on her left ovary

Present Illness—Fourteen months ago she first had a sense of dragging and discomfort in the left loin. This condition, having once become established, was very persistent and was often associated with marked urgency of urination. Usually there was no frequency or dysuria. Occasionally she noticed that her urine was bloody, and most urinary examinations revealed microscopic blood and pus. She had lost about six pounds during the last year and now weighed ninety-four pounds

Both kidneys were palpable, the left was enlarged and tender. The urine contained albumin, pus and blood, and the combined intravenous two-hour phthalein return was 65 per cent. The X-ray revealed several shadows in the region of the left kidney. There was one main shadow about 3 cm. in diameter, this connected to a smaller shadow by means of a narrow isthmus, the entire mass was deemed to be a calculus which resembled a dumb-bell. Several centimetres below this there was a crescentic shadow about 2 cm. in length (Fig. 1)

Cystoscopic Examination—Cystoscopy revealed a mild cystitis. Both ureteral orifices were normal in location and appearance. Clear spurts of urine were being ejected from each ureter. Both ureters were easily catheterized. Specimens of urine from the left kidney contained pus, red blood cells and bacteria. The urine from the right kidney also contained bacteria and a few pus cells. The cultures from both kidneys were positive for colon bacilli. Intravenous phthalein returned from the right kidney after three minutes and drained 8 per cent. in fifteen minutes, it appeared after five minutes from the left kidney and drained 7 per cent. in the same time

At a later cystoscopic examination intravenously injected indigo-carmin returned from both ureteral orifices after five minutes, that from the left, one, and that from the right, two, on a scale of one to four

Operation—Under gas and oxygen anæsthesia the left kidney was exposed through a postero-lateral incision, it was almost twice normal size. The lower pole was rounded, bulbous and oedematous, and there were extensive inflammatory, perirenal adhesions. After stripping off the adhesions, the lower segment of the kidney was about 6 cm. wide, it felt hardened but readily compressible and somewhat fluctuant. The fatty covering over the pelvis was removed and a 2-cm. incision made in the renal pelvis parallel to the long axis of the kidney, this readily exposed the main segment of the calculus, which was removed through this incision. The handle or middle section of the dumb-bell-shaped stone projected through the lower calyx where the smaller, rounded mass completely blocked the drainage from the lower pelvis. It was impossible to remove the

stone in one piece, so it was broken and the larger part removed through the incision in the pelvis. The other fragment of the stone slipped back into the lower part of the kidney (Fig 2). When the lower end of the stone slipped away from the calyx, thick, green pus oozed up through the opening, showing that there was pus under pressure in the lower renal segment and that it was confined there by the ball-valve action of the stone. A transverse incision was then made in the parenchyma of the kidney in an area where apparently normal tissue adjoined the swollen lower segment. The incision opened into the abscess cavity, which contained about three ounces of thick, green pus. The

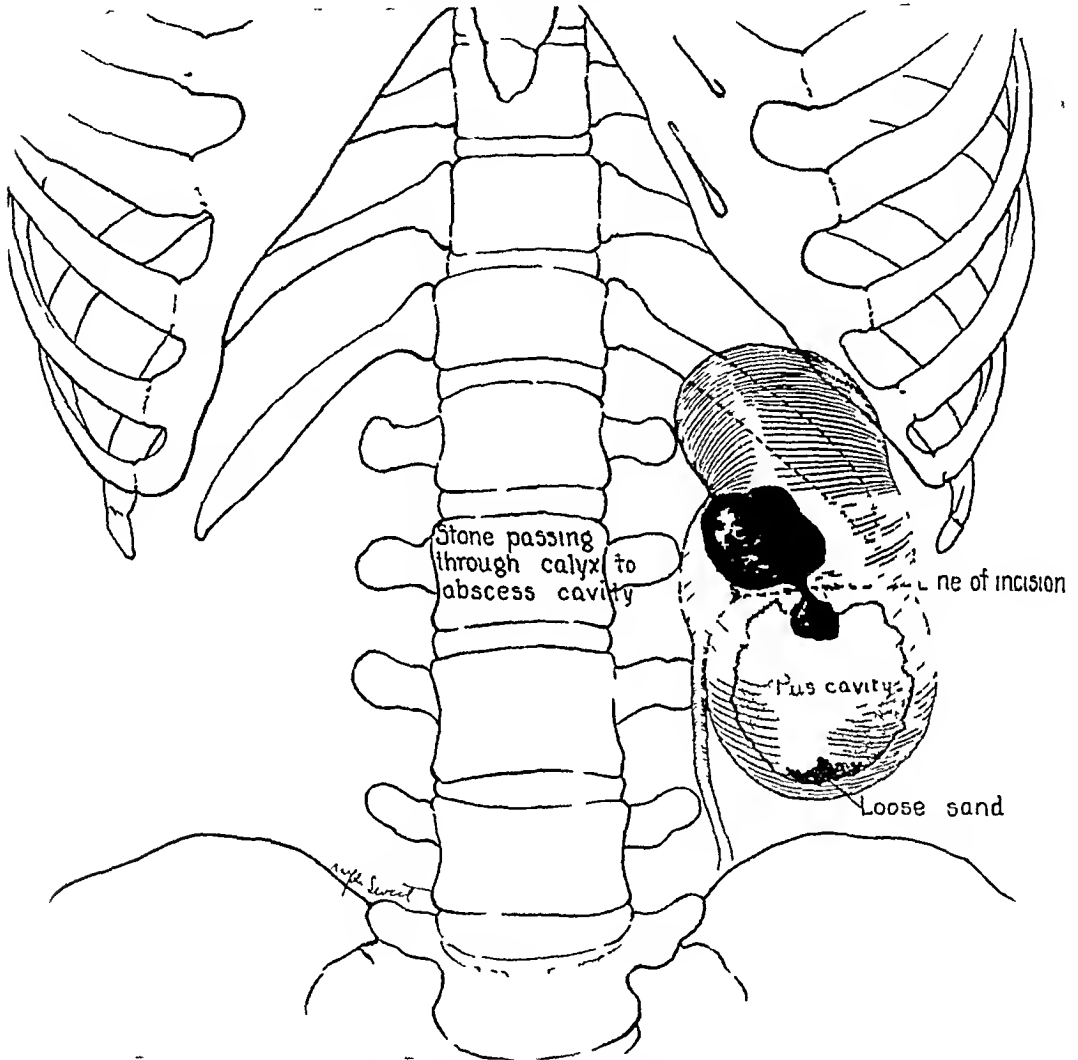


FIG 1—Composite drawing made from X ray and operative findings. Smaller segment of stone completely blocking the lower calyx.

wall of the cavity, which comprised the entire lower third of the kidney, was thin, fibrous and contained very little functioning tissue. The lower segment of the kidney containing several fragments of stone was resected. The incision in the kidney was closed with two layers of No 1 catgut. A soft open-end rubber catheter was inserted through the opening in the renal pelvis down to the line of incision. Several stitches of fine catgut were taken in the fat overlying the pelvis which partially closed the incision in the pelvis (Fig 3). Two soft rubber drains were placed down to the line of incision in the kidney.

Post-operative Course—The catheter drained urine very freely for eight days after the operation and the temperature varied around 100° and 101° F. On the tenth day the temperature was 99° and the catheter was removed, after twenty-four hours no further

KIDNEY RESECTION

urine came from the incision. The drains were removed several days later and the wound healed. The patient recovered rather slowly from the operation and quite frequently had an evening temperature of 99° or 100° F. Two months after the operation she suddenly developed a fever of 102° F and a painful palpable mass was felt in the left loin.

Cystoscopy with a left ureteral catheterization was done, 30 cc of infected urine

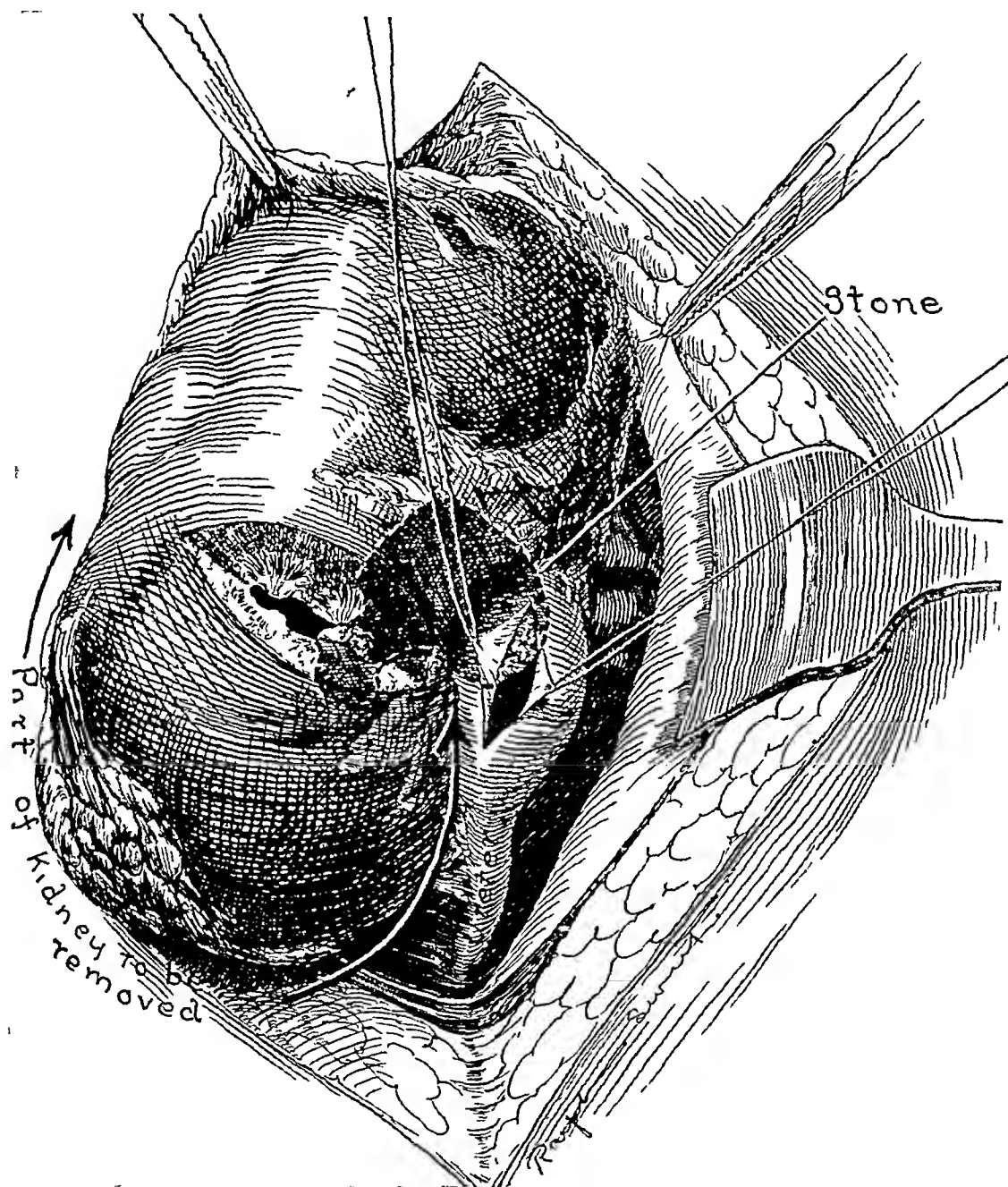


FIG 2—Resection of lower portion of kidney. Larger fragment of stone removed through pelvis, the smaller piece was removed with resected lower pole of kidney.

was removed and the pelvis washed out. The temperature remained elevated, so a ureteral catheter was re-inserted and left in place for four days, following this the temperature returned to normal and the mass and left-sided pain disappeared. During the next two months the temperature varied from normal to 102° F. The patient was cystoscoped twelve times. On some occasions merely a simple pelvis lavage was given, on others the catheter was left in place several days. Almost invariably ureteral catheterization caused the temperature to return to normal at least temporarily. Four months after operation the temperature was normal and the urine from both kidneys was free

from pus or bacteria. Nine months after operation a divided intravenous phthalein test revealed a normal and equal function in both kidneys (14 per cent of intravenously injected phthalein returned from each kidney in fifteen minutes with three-minute appearance time). Sixteen months after operation the bladder urine was not abnormal and the patient had gained sixteen pounds and was feeling in splendid condition.



FIG. 3.—Area of resection closed with two rows of sutures. Fatty flap covers incision in pelvis.

Comment—In the above case a bilateral pyelonephritis was present with a reduction of functional efficiency of both kidneys. It is an example of the results that may be obtained with persistent care and unremitting treatment. At several times during the convalescence the pain, high temperature and evidence of severe infection suggested that the remaining fragment of kidney should be removed. On the other hand, the divided phthalein test indicated

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that the left kidney, though having a reduced function, was of as much, or possibly more, functional value than the right kidney, in spite of the presence of the stone. The phthalein return from a kidney containing a stone does not give an accurate index of the amount of functioning tissue present, usually it suggests much more destruction than is actually present. Consequently, in this case, with infection in both kidneys and with a function in the abscessed kidney equal to that of the other kidney, a conservative operation was indicated. At operation, when it was found that a portion of the kidney must necessarily be removed, a resection was carried out.

SURGICAL TECHNIC AND INDICATIONS

Partial nephrectomy is a more difficult procedure than a simple nephrectomy. Obviously it would be unwise to remove a portion of a kidney if the opposite kidney were doing all the work. The remaining segment having no stimulus to regenerate would, as Hinman¹⁴ pointed out, probably atrophy and would either necessitate a later nephrectomy or it would remain as a source of infection for the entire urinary tract. Kidneys infected with tuberculosis should not be resected. In a series of removed tuberculous kidneys microscopic studies were made of the tissue adjacent to the infective foci. Even in kidneys in which the lesion was apparently well walled off and grossly suitable for resection, isolated tubercles were found in the adjacent tissues and occasionally in areas well away from the infected portions.

In simple infective cases, either complicated by stone or not, partial nephrectomy should not be done unless the pathologic condition is confined entirely to a localized area of the kidney. It is necessary to remove all the diseased tissue and leave only a normal functioning segment. The incision should be made through sound tissue, even though it is necessary to sacrifice a small portion of the remaining or normal segment. If the incision is carried through an infected area, the infection may be carried by surgical manipulation and rapidly invade the normal tissue, also the infected areas of the parenchyma are usually thinned out and friable and do not suture well nor heal normally.

Fistula formation was the *bête noire* of parenchymal incisions and partial nephrectomy in the early days of renal surgery. Almost invariably in these earlier cases the wounds were packed extensively with gauze, both to aid healing and to control hæmorrhage. Consequently fistulous tracts were common. At present urinary fistulæ are rarely seen, as gauze packing is only used in parenchymal incisions in emergencies.

In cases where a resection is performed to remove an infected segment, even though the incision is made through apparently sound tissue, a local fibrosis is generally present. Consequently, hæmorrhage is usually of small amount. An inner suture of continuous catgut will in most cases readily control any internal bleeding and a second suture approximates the parenchyma and serves also as a hemostatic suture. Several interrupted through-and-through catgut sutures are placed through the renal stump for added

safety and they also aid in approximating the two walls of the kidney. The incision should then be covered over with a flap made from adjacent fatty tissue in a similar manner, as is usually done to cover pyelotomy wounds. If possible, in removing the diseased segment, the incision is made so as to remove a wedge of tissue which permits a more accurate closure of the remaining segment.

The healing process resulting after resection was clearly shown in the segment of one kidney which was subsequently removed. The resected surface, though pitted in some areas, was smooth and had assumed the normal rounded contour of one of the renal poles. The pathologic process had involved only the tissues immediately adjacent to the line of incision.

In an occasional case partial nephrectomy may be the only operation permissible. The opposite kidney may have been removed at a previous operation or it may be functionless. This makes it essential to conserve as much functioning tissue as possible. Judd¹³ removed a functionless right kidney from a young woman. The left contained a localized pyonephrosis and stone. At a second operation the diseased area including the stone, which comprised about one-third of the kidney, was resected. Studies of blood urea and renal function have been made at regular intervals since the operation. Three months after operation the urea content in the blood was normal and has since remained unchanged. The fact that this patient went safely through a pregnancy and is now well four years after operation indicates, as has been shown by animal experimentation, that even a part of one kidney is sufficient to maintain life.

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SUPERNUMERARY ECTOPIC URETERS

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THE object of reporting this case is threefold (1) to report an extremely rare condition, (2) to attempt to classify this anomaly into two types, and (3) to justify and further confirm the treatment which has recently been advocated

CASE REPORT—Miss H. S., age twenty, referred by Dr. Josiah N. Hall, January 19, 1926, with the following statement

The patient consulted him on account of pain in right upper quadrant of abdomen, together with seeming discharge from the vagina, and an inflammation of the vagina accompanying the discharge. Doctor Hall referred the patient with the statement: That there was a constant watery discharge from the vagina, which had an inflamed appearance. There was a marked tenderness in the upper quadrant of the abdomen, which tenderness he attributed to a hydronephrosis. He further reported that the patient's pelvis was negative, as were the head, neck, and abdomen (except for the condition mentioned) and that there was nothing further noteworthy.

Family history is negative, except for the fact that she has one sister who menstruated at the age of three months and has menstruated regularly and normally ever since, now being the mother of a family. The patient gives a history of the usual diseases of childhood, with no complications and no illnesses since. Her menstrual history is that of a normal woman. She states that as a child she was whipped for bed wetting and for wetting her clothes during the day. The patient relates that, with the exception of a year (at about the age of eight) she has always been unable to hold her water very well. The amount of leakage was so little, ever since she could remember, that it could be very easily taken care of by one napkin or one cloth per day or night. Furthermore, the condition has been of very little annoyance to her until recently when she began to have pain in the right side and when the discharge began to irritate the vagina. Despite this incontinence, micturition was normal as to frequency and amounts voided and the act was physiologically perfect.

The patient is a well-developed woman wearing a napkin which is but slightly moistened, although it has been *in situ* for seven hours. Concurring with Doctor Hall, tenderness is found in the upper right abdomen. Vaginal examination discloses the vagina of a virgin, very much reddened and inflamed, not encrusted with urinary salts, but containing clear watery fluid. Close observation discloses two papillæ, 1 to 2 millimetres below the posterior border of the external urinary meatus, each being 1 to 2 millimetres on either side of the mid-line, at the place where one would expect to find the openings of the paraurethral ducts. Being watched for a long while, these papillæ were seen to act exactly as does the ureteral meatus in the bladder, namely, to draw back and flatten, remaining dry, and then to push out or raise, the meatus opening up, a single drop of perfectly clear liquid being thrown out. This cycle occurred at long intervals.

Sixteen ounces of a highly colored urine were now withdrawn from the bladder by catheter, and as the fluid exuding from these papillæ was practically as colorless as water, incontinence of urine did not enter into the question, but supernumerary ectopic ureters were suspected. On the basis of this assumption a solution of indigo-carminum was injected into the bladder. This had no effect upon the color of the fluid coming

from these orifices, demonstrating to our satisfaction that there was no communication between them and the bladder

To detail the entire study made of this case would occupy too much space. Suffice it to say that a careful study of the case, including a number of cystoscopies and a number of urograms, was made, gradually leading up to the following findings

(1) The ectopic openings of ureters were traced to blind ends lying above the true kidney pelves on each side. These supernumerary ureters were markedly dilated and both of them were so badly strictured in their vaginal portions that instruments could

not be introduced, although fluids could be. It was with great difficulty that the small openings of the supernumerary ureters were dilated to such size that catheters could be passed into them for the purpose of filling these ureters with fluid impervious to the X-ray

(2) The bladder appeared normal, except for the fact that the ureter mouths were a little close to each other and to the urethral opening. In other words, the trigone was a little smaller than the normal

(3) Indigo-carmin solution injected into the bladder did not appear at these openings, and reversing the process, indigo-carmin injected into these openings did not appear in the bladder

(4) We were unable to insert catheters sufficiently far into these ectopic ureters to collect specimens and therefore cannot say whether infection existed there or not. The presumption is that it did, because of the pain in the right upper abdomen, as well as the inflam-



FIG 1—Both rudimentary pelves and the dilated tubes leading therefrom are well shown filled with sodium iodide solution. Both developed kidney pelves and their ureters, all filled with the same solution are also shown on this same plate. The right ectopic ureter shows the strictured areas near its exit

matory condition of the vaginal mucous membrane. Not being able to collect any fluid we are unable to state that it contained the constituents of normal urine. However, from its constant lack of color we do not believe that it was urine

(5) Solutions of deep indigo-carmin injected into these tubes showed that their course was along and within the bladder wall on each side. The indigo-carmin solution could be distinctly seen in the bladder wall by means of the brilliantly lighted cystoscope

(6) On three occasions, the function of the kidneys was tested by indigo-carmin and found to be normal. On none of these occasions did any trace of indigo-carmin come through the ectopic openings. When polyuria was produced, the speed with which these ectopic openings produced fluid was not increased, even though the polyuria was produced to such extent that 300 c cm of fluid collected in the bladder from the kidneys within thirty minutes. This occurred upon repeated trials. As nearly as could be

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estimated, not more than 15 ccm of fluid was voided from each of these ectopic openings during the same period

(7) As shown in Figure 1, which is a pyelo-urcterogram of the supernumerary and the normal ureters and their terminations, the case corresponds to the reports of most other cases of *supernumerary ectopic ureters*, in that (a) the so-called pelvis connected with the ectopic supernumerary ureters are rudimentary in character, (b) that they lie above the true kidney pelvis, (c) that the course of these supernumerary ectopic ureters conforms in that these ureters cross the normal ureters twice, (d) that they are dilated and (e) that they are strictured near their external openings (Fig 1 shows stricture on right side and Fig 2 shows stricture on left side)

DISCUSSION

Kilbane,¹ in reviewing the literature of ninety-eight cases of "Ectopic Ureteral Openings" together with two original cases, gives an excellent bibliography. He classifies these cases as to whether the ectopic openings belong to supernumerary ureters or not, as to whether there are one, two, three or four ureters present in each case, and as to where these ectopic openings occur, namely, whether in the vestibule of the vagina, in the lateral vaginal walls, in the seminal vesicles, et cetera

He includes in his analysis of these one hundred cases, two cases of complete bilateral duplication of pelvis and ureters with bilateral ectopic openings, one reported by Stammier² and the other by Kummel and Graff³. On closer analysis it appears that these are two different reports of the same case. Therefore, to our knowledge there is but one other case besides ours reported of so-called complete bilateral duplication of pelvis and ureters with bilateral ectopic openings, together with two normal ureters opening normally into the bladder*. Before considering this case further and the operative procedures



FIG 2—The left supernumerary ectopic ureter is here shown for the purpose of calling attention to the strictured areas which prevent the passage of a catheter. These strictures are five centimetres from the lower end.

* Since this paper has been written an article has appeared in *Zeitschrift für Urologie* (22-Band, 1928, Heft 6) by Dr. Bruno Thom, entitled "Harnleiter- und Nierenverdoppelung mit besonderer Berücksichtigung der extravasikalen Harnleitermündungen", and reporting quite a few new cases.

indicated, we believe that a discussion of this developmental error is in order, because it will lead to a better classification of these cases and be conducive toward better and more standardized surgical procedure

Anomalies of the genito-urinary system are by no means rare, but have been repeatedly described in the literature during the past fifty years. In 1904 Pohlman⁴ described anomalies of the urinary system in two human embryos (13 mm and 24 mm in length) which appear to have influenced the interpretations on most cases observed in the adult since that time. The conditions observed in the embryos described by Pohlman, obviously, point to a splitting of the original metanephric or kidney bud as one method in the formation of supernumerary ureters and kidneys. That supernumerary ureters and kidneys may be formed by another method has recently been established by Chwalla⁵ (1927) who found two separate anlagen or buds on the mesonephric or Wolffian ducts.

The case that is reported in this paper contains certain features which call for a different interpretation than has been applied to similar cases. It also appears probable that the cases described in the last twenty years represent at least two distinct types of anomalies: (1) supernumerary kidneys and ureters due to splitting of the original kidney bud or due to more than one kidney bud on the Wolffian duct, (2) the retention of mesonephric tubules and the Wolffian duct, in which case the "supernumerary ureters and kidneys" are not true kidneys and ureters. The older interpretation of supernumerary ureters and kidneys was that they represent the persistent remains of the Wolffian duct and some of the Wolffian or mesonephric tubules. This thought is well expressed by Furniss⁶ who says, "Probably further study will show that with accessory extravesical openings the upper pole will be found quite rudimentary. This rudimentary development, however, does not always hold true in the cases of double ureters where the opening is intravesical. To better appreciate the developmental possibilities of the genito-urinary tract, a brief review of the early embryology may be of value.

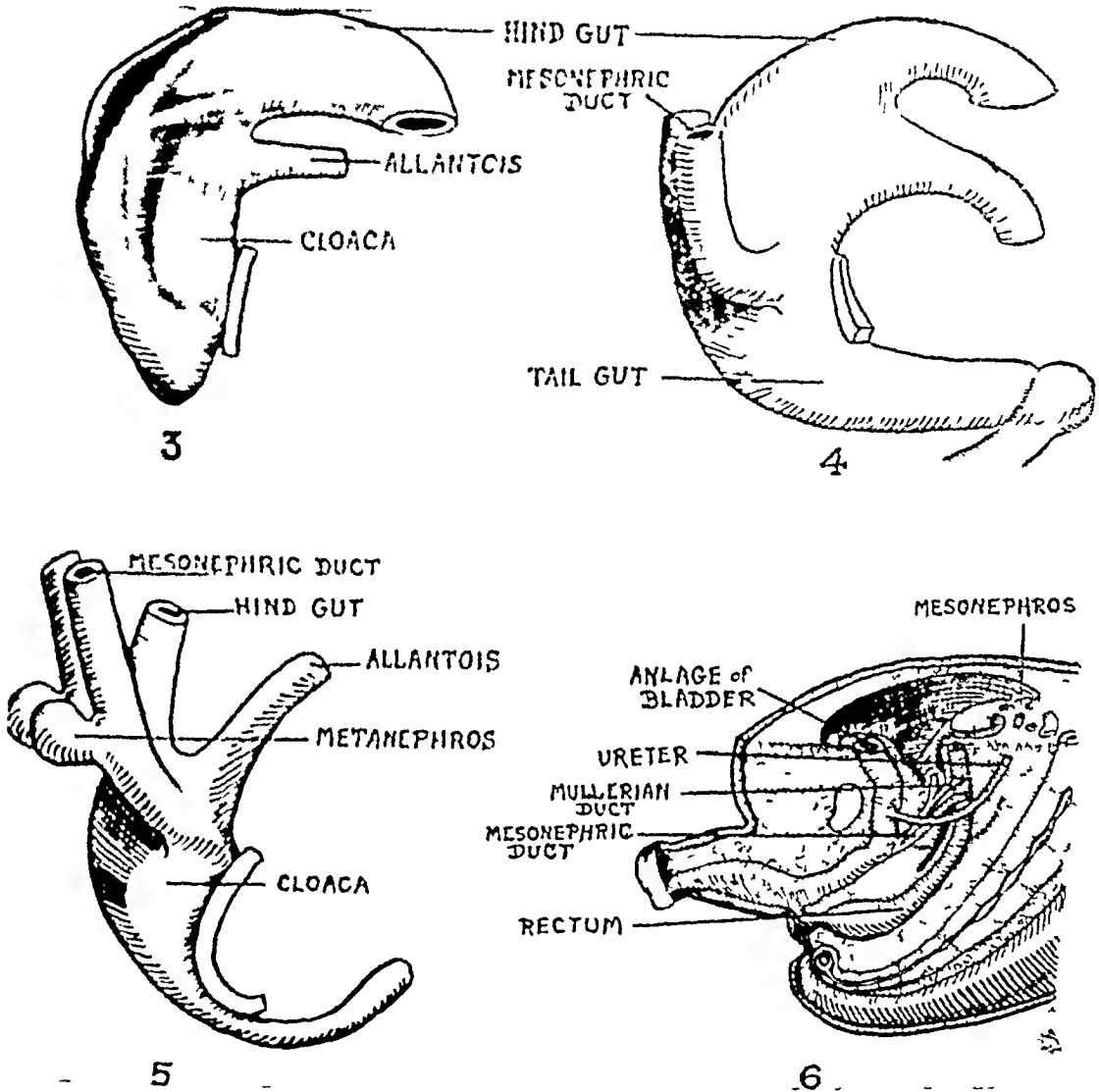
The first indication of an excretory system in human development appears in embryos of about 17 mm in length. This consists of a series of tubules known as the pronephros. The tubules are segmental in arrangement, and in morphology they remind one somewhat of the excretory tubules present in the earthworm. The tubules join to form a longitudinal duct—the pronephric duct. The tubules as such degenerate early in embryonic life, but the pronephric duct persists and later is known as the mesonephric or Wolffian duct. Cysts that have been found in the adult mediastinum of the thorax are thought to be the persistent remains of the pronephric tubules.

Soon after the degeneration of the pronephric tubules, a second set of glomeruli and tubules develop and unite with the mesonephric duct. These are the mesonephric or Wolffian tubules. The mesonephric ducts grow caudad and gain entrance into the cloaca—the common chamber of the digestive tube and the genito-urinary tube (Figs 3 and 4). The cloaca later divid

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by a longitudinal fusion-division into two separate tubes, a dorsal rectum and a ventral bladder and urogenital sinus (Figs 5 and 6)

The mesonephros in both sexes undergoes an early degeneration which is only partial in character involving some of the anterior and posterior groups of tubules. Later a second degeneration takes place which varies in the two sexes. The mesonephric or Wolfian tubules degenerate almost



FIGS 3, 4, 5 and 6—Various stages in the development of the urogenital system
(After Prentiss and Arce)

completely in the female. Some of the upper tubules persist as the epio-phoron and a few of the lower tubules become the paroophoron located in the broad ligament. Most of the mesonephric duct in the female degenerates, the lower end persists as Gartner's canal which may vary considerably in extent and point of exit. In the male the upper mesonephric tubules are transformed into the ductuli efferentes of the epididymis, the mesonephric duct becomes the ductus deferens and the ejaculatory duct.

The metanephros or permanent kidney originates from two distinct sources. The medulla, pelvis and ureter develop from the kidney bud or

metanephros, an outgrowth from the mesonephric duct (Fig 5) The kidney bud grows dorsally into the embryonic mesodermal tissue At the point of contact the mesodermal tissue condenses to form a blastema from which the cortical portion of the kidney is elaborated While the kidney begins its development in the caudal part of the abdominal cavity, the subsequent growth of the lower abdominal or pelvic region of the fetus together with a very slight cephalad migration of the kidney results in a more cephalad location of the kidney in the adult

By a process of fusion-division the ureter which was an outgrowth from the mesonephric duct gains an independent opening into the bladder (Fig 6)

The bladder and urogenital sinus undergo considerable modification in later development The ventral urogenital sinus grows to the surface and opens to the outside, forming the urethra The mesonephric ducts are carried forward in the growth process In the male they empty into the urethra as the ejaculatory ducts, while in the female they lose their connection with the urogenital tube and gain independent openings in the walls of the vagina and persist as Gærtner's ducts

From the rontgenological and direct examinations made in the case described in this paper, it appears that the anomalies present represent the persistence of the mesonephric or Wolffian ducts and parts of the original mesonephric tubules That these structures, as such, may persist into the adult does not appear to have been considered in the recent literature

In many cases of supernumerary kidneys, the accessory kidneys appear to have distinct pelves, and it appears obvious in such cases that the supernumerary kidney originated from a splitting of the original kidney bud or from double anlagen on the mesonephric duct In the case here reported there are no pelves indicated in connection with the ectopic ureters, but they appear to end rather blindly at the upper poles of the kidneys Such a relationship indicates that there is no true kidney structure present It appears likely that the tissue connected with the ectopic ureters represents a persistence of mesonephric tubules Obviously, to determine this it would be necessary to make a careful histologic examination of the tissue This was not possible in the case under consideration, as the patient would not submit to a heminephrectomy In the few pathological reports that have been published on the nature of the tissue draining into the ectopic ureter, there has been reported hydronephrotic kidney tissue In a number of cases reported in the literature the kidney containing the accessory ureter was greatly elongated, and the part drained by the ectopic ureter was distinctly marked off on the surface by a shallow depression from the remaining part of the kidney If the tissue in question were in reality mesonephric tissue, this would not be greatly different in appearance to hydronephrotic kidney tissue The mesonephric tubules and glomeruli are considerably larger than the same structures in normal kidneys, and it does not seem unlikely that a cursory examination of mesonephric tissue may be mistaken for hydronephrotic tissue As regards the persistence of the mesonephric or Wolffian duct, the evidence in the case

that he can demonstrate a secretion in the tubules Ernst⁹ (1926), on the other hand, believes that the masses found within the tubules represent degeneration masses and that the mesonephros does not secrete In the case reported in this paper, there is a secretion coming from the tissue drained by the ectopic ureters From the superficial examination made of this secretion it does not appear to be urine Obviously, it is necessary to carefully examine the tissue histologically before one can definitely state that it represents embryonic tissue

Treatment—Various methods have been suggested in the treatment of incontinence in the female, due to ectopic ureteral openings The following methods have been used

(1) The tying-off of the ectopic tubes in the vagina—a minor operation—with the hope of producing atrophy of the corresponding kidney

(2) “Pyelo-pyelostomy” as performed by Kummel³ This consists of an attempt to connect the upper end of the supernumerary tube to the kidney pelvis on the same side

(3) The introduction of the aberrant tube into the bladder

(4) The draining of the ectopic ureter into the bowel

(5) “Heminephrectomy” or the removal of the part drained by the supernumerary ureter, namely, the upper pole

It is evident that ectopic ureters are of two kinds (1) Those that are supernumerary and (2) those that are not This study is concerned only with the supernumerary type

In the treatment of this patient unfortunately, we could not obtain permission to do that which we considered best namely, the removal of the upper portions of the kidneys It was the plan to remove these upper poles on two different occasions, giving the patient ample time to recover from the first operation before the second was attempted The second operation was to be made only in the event the first operation was a success However, she would submit to no major operation, maintaining that the condition did not bother her sufficiently to warrant such procedure

When the various methods of attacking the problem were presented to her she consented to the tying-off of each tube underneath the vaginal mucous membrane, and this was attempted A catheter was placed in each of these ectopic openings It was easy enough to dissect back of the catheters and to pass a ligature around each of these ectopic tubes However, it was recognized at the time that this was done that there was no ureteral wall in this case There appeared to be only an epithelial tube with no muscular support and no fibrous covering It was feared that the silk ligature would cut through This is exactly what occurred and is here recorded so that this operation should be undertaken in the future with this probable failure in mind

From a consideration of our case and a study of the literature on ectopic ureters, we propose that these anomalies be distinguished by two types, as follows

(A) Those cases in which the so-called supernumerary ectopic ureter is

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not properly speaking a ureter, but a persistent mesonephric duct, and the body which it drains is a persistent mesonephric remnant. Obviously, if this body which is drained by the supernumerary ectopic ureter is a mesonephric remnant, its removal would not interfere with total kidney function. While we have no way of knowing before operation the type of blood supply to the normal kidney and the accessory structure in any individual case, it has been found, almost universally, both in operated and autopsy cases, that the accessory body has its own blood supply. Its removal is therefore practical. "Pyelo-pyelosomy" would be more difficult of performance and would have no advantage over a heminephrectomy. Since the evidence of others shows that these so-called supernumerary kidneys are generally infected, it would be an error to lead the tubes from them into the bladder and expose the bladder to infection, thus also endangering the true kidneys. We have found that the ligating of the supernumerary ureters at their lower ends is impractical, despite the apparent success of a few cases reported in the literature. Other operative procedures reported in the literature do not warrant any discussion.

(4) The cases of ectopic ureters that are not supernumerary, do not appear to drain embryonic rests or remnants, and have not been studied by us. Consequently we have no suggestions to offer regarding their treatment at this time.

CONCLUSIONS

We have presented a case with two normal kidneys, each containing one normal kidney pelvis, and each pelvis leading to the bladder by a ureter normally placed. The possessor of this normal urinary system has two accessory bodies, one resting above each kidney, and these bodies secrete a fluid in no way resembling urine. This fluid is conducted outside the body by tubes which open at the position of the paraurethral ducts, one on each side of the mid-line. Further, these tubes follow the course in the walls of the bladder and vagina that is usually taken by Gartner's canal, which has long been known to be the persistent remains of the mesonephric or Wolffian duct.

(2) We have attempted to classify the so-called ectopic ureters so that the supernumerary ectopic ureters may be considered from a different point of view than the ectopic ureters which are not supernumerary.

(3) For the cases of supernumerary ectopic ureters, we wish to endorse the view of Furmiss, Herlist and Polky,¹⁰ and Kilbane, approving "heminephrectomy."

(4) We wish to emphasize that cases similar to the one we have described are strongly suggestive of persistent embryonic structures.

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THE ETIOLOGICAL RELATIONSHIP OF CHRONIC APPENDICITIS AND THE SMALL CYSTIC OVARY

BASED ON A STUDY OF 256 CASES

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SOME YEARS ago I noticed that my cases of chronic appendicitis were often associated with tender and enlarged ovaries of the small cystic or hyperplastic type. It seemed as if the right ovary alone was more often affected than the left alone.

We decided to take careful notes on the ovaries of these cases and it fell to the lot of Kethley William, pathologist to Hale Hospital, to inspect and record the gross appearance of these ovaries at the operating table. Nearly all of the cases reported were received from the pathologist's viewpoint and likewise the histologic of our specimens were made by the same person.

At the onset let me state that the ovarian condition in this series is reported only in those cases in which chronic appendicitis was demonstrated histologically and in most cases macroscopically.

I know there are men who teach that there is no such disease as chronic appendicitis. One of my medical associates who recently spent a year in one of our leading universities came home thoroughly convinced that even acute appendicitis did not exist because he did not see any in the wards and no one said anything about appendicitis except to deny it, but he was strong to the gall-bladder. After I had shown him a half dozen appendiceal abscesses within a short time his mind reluctantly condescended to drop below the transverse umbilical line again.

When I studied pathology we were given sections of the appendix as a very fine example of chronic inflammatory reaction.

John B. Deaver¹ says "In discussing chronic appendicitis let me take this opportunity to protest against the practice of teaching by word of mouth or by pen that chronic appendicitis is not a clinical entity, and that too many so-called chronic appendices are being removed. Chronic appendicitis, I say, is a clinical entity and a surgical fact and not a fancy. It may be grouped into two types: the first follows attacks of acute appendicitis, and the other is chronic from the onset."

While it is generally known that acute appendicitis can produce ovaritis by contiguity or by infection being carried through the lymph channels in Clado's ligament as maintained by Deaver and denied by Kelly, but that chronic appendicitis has any action deleterious to the ovary is scarcely mentioned in the English literature. So our study has given us something to think about.

I have been able to demonstrate to my own satisfaction that there is such a structure as Clado's ligament which in some cases is well marked.

As I studied the sections of these chronically inflamed appendices microscopically, I noted in practically all of them definite changes in the serosa. The blood-vessels and capillaries were surrounded by chronic inflammatory cells and grossly, by very definite peritoneal reactions of the cæcum, ascending colon and adjacent parietal serosa.

I have demonstrated many times to my assistants, the effect particularly of the chronically diseased appendix upon the retroperitoneal layer as evidenced by a thickened transparent peritoneum in which are imbedded a great



FIG. 1.—A group of plasma cells and some lymphocytes located in the serosa of a chronically inflamed appendix, a very common finding.

number of fine long red capillaries generally running in a more or less parallel direction. This reaction corresponds definitely to the areas swept by the appendix attached to a more or less mobile cæcum. I have often likened this phenomenon to the bare ground produced by a dog chained to his kennel.

The moist condition of the abdominal viscera is due to a very finely adjusted transudation of fluid from the peritoneum. If there is sufficient toxic material in the serosa of the appendix to bring about a perivascular reaction of greater or less degree, then one would naturally assume that the fluid thrown out for lubricating or other purposes might contain a greater or less amount of toxins which if not rapidly detoxicated would likewise cause cell and tissue reactions wherever present. Every abdominal surgeon of experience is familiar with these reactions. Since someone has reported something like 20 per cent of appendices in operation cases situated in the pelvis, the right ovary especially would be subjected to the action of toxic fluid. It is not uncommon experience at all to encounter in these cases of chronic appendicitis an ounce or more of free fluid in the cul-de-sac of Douglas and bathing the ovaries which are very often prolapsed into this pocket of slow absorptive power.

That the ovaries do react is evidenced by the more or less thick tough, white cortex and everyone seems to be agreed that the thickened cortex is the cause of failure of the graafian follicle to rupture at maturity and a retention cyst results.

Papers on appendicitis are comparatively infrequent now and the ovary in medical literature is treated like the black sheep of a family. The pendulum has swung from fiendish radicalism to extreme and unreasonable con-

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servatism In fact word has come to me from high authority that an ovary never was tender or painful or produced a single symptom

I have read all of the books in the Library of the University of Cincinnati College of Medicine on the subject of the follicular cyst, and chronic appendicitis as an etiological factor was not discussed At the Cincinnati General Hospital Library, I found only a few articles in English that recognized the etiological relationship of chronic appendicitis and the follicular cystic ovary However, the French and German surgeons seem to have given some thought to the subject

My purpose in presenting this paper is to call attention to the baneful influence of chronic appendicitis upon the ovary and to urge the early removal of the diseased appendix and thus conserve the ovary and its important internal secretion

Analysis of Our

Cases—Of 256 cases of chronic appendicitis analyzed within a given period of time 76 per cent were associated with the small cystic ovary affecting one or both ovaries and 24 per cent were unassociated with the cystic ovarian condition

In my cases of chronic appendicitis associated with the small cystic ovary which have been studied, the age of the patients ranged from eight to fifty-one years with an average age of twenty-two years Fifty-eight per cent were married and 42 per cent unmarried The duration of the time of symptoms of appendicitis ranged from ten days to thirty years with an average time of four years In 28 per cent of these cases the right ovary was affected alone, 6 per cent the left ovary alone, and in 66 per cent both ovaries were affected When both ovaries are affected, the right is larger than the left usually and this fact I think is a striking and significant observation Sixty-three per cent gave history of dysmenorrhœa, 26 per cent no dysmenorrhœa and 11 per cent indefinite menstrual history

It is well to note here that the midline incision is the ideal incision for every woman and the one which I routinely employ since it gives full opportunity to take care of any pelvic complication which may be encountered

From a practical standpoint I have reached the place where I feel that an

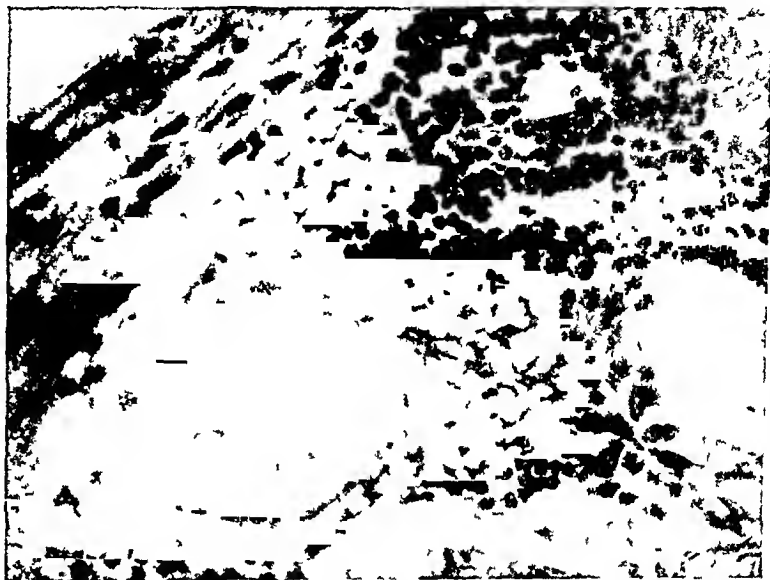


FIG 2 —A marked perivascular collection of small lymphocytes a common finding in the serosa of the chronically diseased appendix The fine long capillaries in the serosa of the cæcum are surrounded by cuffs of these cells at varying intervals as shown by whole mounts

enlarged and tender right ovary, non-specific, means chronic appendicitis even though the appendix is not tender, an operation is clearly indicated

I wish to quote from a few authors to substantiate my thesis Clarence Reginald Hyde² quotes Schmitt as believing that a chronic appendicitis may cause pelveo-peritonitis C B Lockwood³ says, "I do not know why an ordinary cyst of the right ovary should be so often associated with appendicitis unless it be that Clado's ligament forms a more potent continuity of tissue than some think Inflammation of the appendix may be associated with tumors of the uterus"

L N Lapeyre⁴ reports seventeen cases from which he concludes that chronic appendicitis in women seems to be habitually accompanied by degeneration of the ovaries The ovarian lesions may cause spontaneous and induced pain during and between the menses, dysmenorrhœa, irregular menstruation and hæmorrhage The uterus at the same time generally shows signs of hyperplasia and is often displaced The whole trouble is probably some primary disturbance in the sympathetic nervous system, this explains the alterations in the various organs as the nutrition suffers—ptosis, colitis, and sclerocystic degeneration of the ovaries and chronic inflammation of the appendix The central nervous system irritated by some peripheral disturbance in some lesion of the vulva, vagina, uterus appendix or pelvis reacts by a reflex mechanism of the trophic nerves of the ovary Treatment should aim to cure local lesions before the central nervous system has been too seriously impaired When the abdomen is opened it should be on the median line in women so as to permit systematic inspection of the entire pelvis and appendix region

Drs W H Luckett and Frank Grauen⁵ state that follicular cysts occur more frequently in the right ovary on account of the appendiculo-ovarian ligament, a fold of peritoneum which runs between the base of the appendix and the hilum of the ovary in which there are a great many lymph channels and on account of absorption of toxins from chronic appendicitis

Often chronic appendicitis causes gastric disturbance, pylorospasm, intestinal indigestion as well as constipation due no doubt in part at least to irritation of the sympathetic nervous system Certainly such a general abdominal disturbance as this would also cause reactions of some sort (trophic) in such complex and sensitive organs as the ovaries

The majority of writers are agreed that follicular cysts are due to ovaritis, although a few men and among them some of the best, contend that these cysts are normal If ovaritis is the main cause, then the great frequency of cystic ovaries in girls and women free from any possible specific infection, must derive their cysts from infection to be found in a diseased appendix alone This particular group of patients give us our clearest view into the causal relationship of appendicitis to follicular cysts

I do not wish to go on record as saying that appendicitis causes all follicular cysts, but rather that the diseased appendix has a far more baneful effect upon ovaries than is commonly recognized

From a study of our ovarian material, gross and microscopic, I am of the opinion that the conditions we see are not all reactions of ovaritis, but rather toxico-trophic changes analogous to the fibrous changes we see in the muscles of laborers and athletes In other words, we have a toxic hyperæmia (a source of more food) with an actual increase in the stroma tissues, particularly on the cortical surface and by its toughness preventing the rupture of normal graafian follicles In many instances this stroma reaction is so

general that few graafian follicles are able to develop and consequently few if any follicular cysts, even in ovaries twice the normal size, are seen

In acute ovariitis polynuclear leucocytes are abundant and the ovary reacts with chronic inflammatory cells but not of the marked degree that we see in the appendix. There are different degrees of fibrosis taking place in these ovaries

The first problem before us was to determine whether or not these cysts were normal graafian follicles in different stages of development as some surgeons maintain. As I have been generally interested in the cytology of the mysterious germ cells for many years, I had a further inducement to make serial celloidin sections of our human ovarian material, searching carefully the unstained sections for the ovum surrounded by its discus proligerus. While I was very anxious to collect all of these ovules I could find,

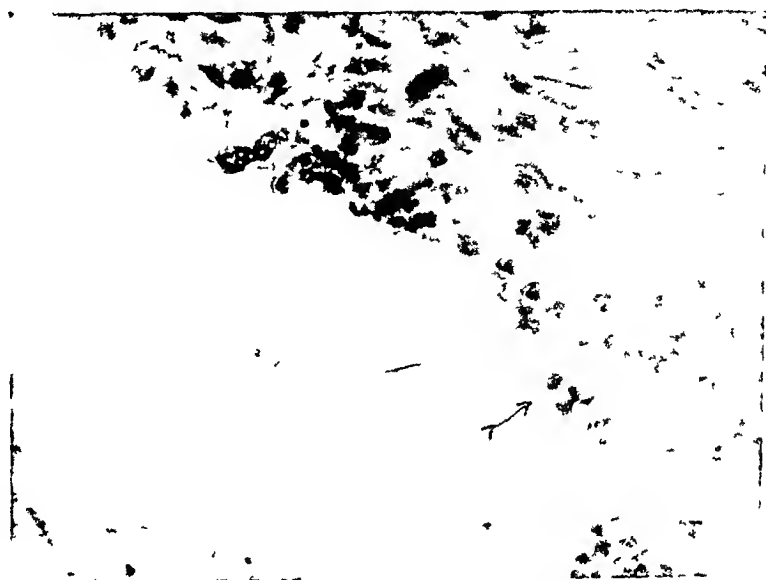


FIG 3—This shows a detachment of leucocytes invading the serosa of an appendix, representing a stage of acute exacerbation

nevertheless, the fact remains, after much hard work that we found very few normal graafian follicles with ovules to add to our collection. Although many surgeons claim they can tell a graafian follicle grossly from a follicular cyst, I must confess in the light of our research that I have been unable to do so and furthermore any surgeon who wishes to puncture follicular cysts can carry out his technic with little fear of destroying an ovum

Pathologists have been unable to add anything to Virchow's classic description of follicular cysts made in 1865 and which is as follows: "The characteristic feature of the true follicle hydrops is that in the beginning of its formation, at least an ovum is found in the fluid, because the formation occurs thus, that a larger quantity of albuminous watery but not mucoid fluid accumulates in a graafian follicle that usually contains a cell mass, an ovum, and a membrana granulosa. Later on the ovum dies. One can clearly see how it disintegrates. First its protoplasmic mass becomes a softer substance which is easily divided and is finally completely dissolved. Then there is merely a serous sac left. Occasionally this cystoid degeneration occurs in a solitary follicle, and in the main it can be accepted that unilocular hydrops of the ovary is of follicular origin. But I have shown that not a few ovarian dropsies which are multilocular in the beginning secondarily coalesce and form a single sac."

It is only those cases of follicular cysts of the ovaries that are not due to the following possible causes exclusive of appendicitis that I wish to stress, the presence of a diseased appendix is the only apparent if not real cause. The general causes to be enumerated are pyosalpinx, chronic adnexal lesions, peritonitis, myoma, retroversion and other misplacements, metritis and perimetritis, venous hyperæmia from prolapsed ovary, too slight congestion and interstitial oophoritis.

Graves is of the opinion that in certain instances it is likely that dis-

turbances of circulation, such as repeated or continuous hyperæmia may cause a too rapid development of the primordial follicles and hence an overproduction of atretic follicles.

While it is generally conceded that the corpus luteum regulates through its internal secretion the mechanism of menstruation, I have often wondered



FIG 4—Loose battle formation. Leucocytes advancing into the serosa certainly to attack an ambushed enemy

what selected a certain ovum in most cases to develop and ripen in preference to hundreds of others, although more than one ovum are at times discharged together.

A study of the egg formation in insects and nematodes has shown me that their eggs are formed in long tubes in which we can see all stages of development down to the finished and ornamented product, and representing an exquisite series of metabolic gradients both individually and collectively.

Although in the human ovary we cannot see any definite linear arrangement of ova like in the cabbage butterfly, for instance, save as suggested by the egg tubes, nevertheless there must be some physiological gradient here analogous to lower life that is not morphologically apparent because as Graves points out, there are only about 14 to 18 follicles that reach maturity each year. In the ovaries of young rabbits there are so-called egg tubes of Phluger growing in from the germinal epithelium, a condition such as suggested above.

Undoubtedly in ovaries with a thickened cortex there is an upset of the normal physiological cycle. The accumulation of fluid in atretic follicles seems to contribute to further degeneration of normal follicles. G. L. Rhodenburg and A. M. Hellman⁷ have shown that injection of saline extract of corpus luteum into guinea pigs causes marked cystic degeneration with loss of normal recessive phenomena.

CHRONIC APPENDICITIS AND THE SMALL CYSTIC OVARY

Since many cases of chronic appendicitis follow acute attacks, we have here a source of ovaritis infective in character and a cause of cystic ovaries. Appendiceal adhesions, more or less marked, are common and indicate that the local infection has extended beyond the appendix. Patients operated upon in this stage of acute inflammation will often have their wounds infected from germs free in the peritoneal fluid. Those cases of appendicitis which are chronic from the onset probably affect the ovaries through toxins liberated through the serosa. No doubt toxins carried by the lymph and blood streams from the appendix also affect the ovaries.

If it were true that small cystic ovaries are never painful or tender and never give rise to symptoms, nervous or otherwise, there would be no need for this paper. However, after carefully studying our cases, I am thoroughly convinced by the evidence that chronic appendicitis in women on the whole, presents a more complex symptomatology than in men.

Where the ovaries are affected, often they present more marked reflex and gastric symptoms than do those patients with no cysts of the ovaries. Dysmenorrhœa is not uncommon and with only one ovary cystic, the former is apt to occur on alternate months. I have in mind a patient, daughter of a physician and a teacher in one of our large city High Schools who, before she came under my care had suffered for years from dysmenorrhœa and had her uterus dilated twice by a very competent gynecologist of Cincinnati. No relief was experienced and the pains were so severe that morphine had to be resorted to each month. Examination revealed that she was suffering from chronic appendicitis and both ovaries were enlarged and tender to touch. Removal of the appendix and plastic operations on the ovaries completely cured her and she has no desire for morphine.

A very reputable surgeon of Chicago told me that the pain or tenderness that we think is in the ovaries comes from the appendix, and that when the appendix is removed the pain stops. To refute this idea which is seldom true and at the same time to show how difficult it is always to do the right thing in these cysts of the ovaries, I cite the case of a girl eighteen years of age suffering from chronic appendicitis and small cystic ovaries. The appendix was removed and the cysts punctured. She was soon much improved, gained weight and after some months she began to have severe pains at her periods with great tenderness and some enlargement of her left ovary. Being put to bed, we were forced to reoperate upon her removing the left ovary, the cysts having refilled, it was removed because the entire organ was a mass of small cysts. She was cured following this operation.

It has always been and is still a question with me what to do when we encounter these small cystic and hypertrophic ovaries in the course of an appendectomy. It would seem as you will see later that the majority of surgeons and gynecologists recommended no interference that is, no puncture, plastic or removal of the diseased ovaries.

Three things I have long since learned in practice, first, to have an open mind and to accept no man's diagnosis or opinion on faith. One must

observe and think for himself, consequently I have practiced the usual classical surgical procedures upon this type of ovaries and observed results

I feel that the removal of the appendix as a source of toxic and infective irritation of the ovary is all that is required in many cases, however those with tender ovaries, dysmenorrhœa, nervous and exaggerated gastric and reflex symptoms require some type of surgery either puncture if only one or a few cysts are present, plastic for very large prolapsed organs, and where there are a great number of cysts both on the surface and within the ovary



FIG 5 —An ovum ready to escape but unable to do so because of a thick tough ovarian cortex

either subresection or removal is indicated I try to be as conservative as possible I do not think that anyone has a right to be dogmatic in his method of treatment, for I have had the family physician tell me later that I should have removed Mrs E's right ovary or that Mrs F was no better after resection of both ovaries, etc It may be when I get my

mind perfectly adjusted to all these different results, that it will be time for the conservatism of age to set in and dominate my practice

One point I wish to make is that sensory nerves which have withstood constant irritation for long periods of time require considerable time to recover their normal function, if they ever do Therefore early interference in cases of chronic appendicitis should be instituted in order to stop this nerve irritation I have examined many patients following appendicitis and find that they retain their tender points for years even though they are well

Just as we can have what Deaver calls the cirrhosis of delayed operation, we can also have marks of delayed operation upon the sympathetic nerves and plexus to the appendix and ovaries

We must have early operations for appendicitis in women if we expect to avoid ovarian complications and the bad results of ovarian surgery in late cases I think that most surgeons and gynecologists agree that the unilocular cysts that may reach the size of a hen's egg with the remaining portion of the ovary practically normal, require resection Very often they occur on the dependent end of the ovary

Findley⁸ has well stated the indication for surgery as follows "Cystic degeneration of the ovaries doubtless contributes to a general nervous state, but in my judgment this can only be due to the local discomfort I doubt if

there can exist a general disturbance of the nervous system referable to the ovaries without local disturbance. Therefore in the absence of local disorders, the general nervous phenomena should not call for surgical intervention or for interference with the ovaries."

A summary of the answers to a questionnaire sent to surgeons and gynaecologists in our great medical centres, all members of the College of Surgeons, pertaining to different phases of the small cystic ovary is appended. A glance at it will convince anyone that the "perfect day" of our knowledge on this subject is far off.

The questions and analysis of the answers are as follows:

1. What do you think is the cause or causes of follicular cysts of the ovaries?

2. What do you think is the cause of follicular cysts of the ovary when not associated with tubo-uterine disease or pelvic inflammation?

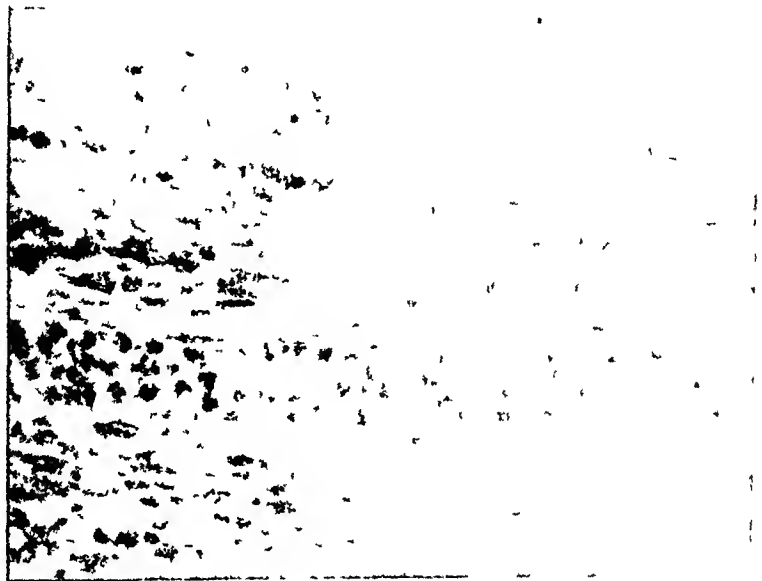


FIG. 6.—A photomicrograph of Fig. 5 showing the wall of the Graafian follicle paralleled by a blood-vessel crowded with leucocytes.

Answer. There seems to be a diversity of opinion among surgeons and gynaecologists as to the causes of the above since there were 64 different opinions offered on the first and 65 on the second, showing a wide range of fact and imagination.

3. Are follicular cysts normal? Yes, 28 per cent. Yes, with reservations 12 per cent. No, 51 per cent. Doubtful, 9 per cent.

4. Do follicular cysts cause referred symptoms? Yes, 43 per cent. No, 26 per cent. Sometimes, 16 per cent. Doubtful, 15 per cent.

A few symptoms suggested are pain qualified as intense or pain in ovary, hot spot, burning sensation, produced under such conditions as prolapse of the ovary, enlarged ovary, pressure on nerves, dysmenorrhœa, pain at time of ovulation, soreness coincident with the menstrual period and chronic appendicitis.

5. Do follicular cysts ever produce painful or tender ovaries? Yes, 62 per cent. No, 15 per cent. Sometimes, 16 per cent. Doubtful, 9 per cent.

Conditions suggested which produce the above are large and tender ovary, pressure, prolapsed ovary, hæmorrhagic condition, tension and ovaritis.

6. Do follicular cysts ever cause dysmenorrhœa? Yes, 46 per cent. No, 32 per cent. Doubtful, 16 per cent. Probable, 6 per cent.

7. Do follicular cysts cause other menstrual disturbance? Yes, 42 per cent. No, 29 per cent. Sometimes, 11 per cent. Doubtful, 18 per cent.

8 In your opinion, do follicular cysts occur more frequently in one ovary than the other, if so, which one? What is your explanation? Right ovary alone 40 per cent Left ovary alone, 32 per cent Both ovaries, 28 per cent

The following explanations are offered for this condition

Left ovary, due to poor circulation, trauma of the sigmoid, circulation disturbed by constipation, direct line for infection, blood stasis on account of anatomical arrangement of ovarian vein

Right ovary, due to cæcum and appendix, most incisions permit best view of right ovary and it is more often examined, inflammatory condition on the right side of the abdomen, result of appendiceal irritation with increased vascularity in this region and proximity to the appendix

Both ovaries, due to blood stasis

Causes of the hypertrophic ovary are set forth as inflammation, hyperæmia, circulatory irregularities, rupture of follicle not taking place, congenital or endocrine, active sex life, associated with uterine fibroids, thyroid endocrine disturbance

10 What causes the ovarian cortex to become thickened and tough, either with or without cysts, in the absence of any pelvic inflammation or uterine displacement?

A great number either did not answer or said that they did not know, but at least a variety of opinions were offered as there were forty-five different causes set forth causing a thickened cortex

11 Do you think that toxins which find their way into a normal amount of peritoneal fluid from abdominal disease such as inflammatory affection of the gall-bladder, stomach, colon, etc., could have any effect upon the ovaries? Yes, 18 per cent No, 64 per cent Doubtful, 9 per cent Possible, 9 per cent

12 Do you treat small cystic ovaries surgically? Yes, 39 per cent No, 46 per cent Sometimes, 15 per cent

13 What is your treatment? Many state that treatment depends upon the size of the cyst and state of the patient Otherwise the treatment suggested covers a wide range of medical and surgical procedure

14 Can you distinguish between a follicular cyst and a graafian follicle by inspection alone? Yes, 39 per cent No, 45 per cent Doubtful, 16 per cent

15 Do ovaries possess sensory nerves? Yes, 75 per cent No, 18 per cent Probable, 7 per cent

The following is quoted from remarks which were made pertinent to this subject

"Operate upon a young woman for mild type of chronic appendicitis, remove the appendix, inspect ovary, if cystic and small, stab and express Leave this ovary without this procedure and she will continue to have pain and that burning spot"

"A normal ovary is not sensitive"

"Pelvic pathology causes are little known"

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"It may be that escape of follicular fluid is irritative in some individuals and hyperplastic connective tissue forms in the ovarian cortex as it does elsewhere in the body in response to persistent irritation"

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ADENOCARCINOMA OF THE TESTIS IN THE ADULT

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THE origin of the common cellular malignant tumors of the testis has never been fully determined. For many years two somewhat divergent views have been maintained. Wilms and Pick, making many sections in all portions of malignant tumors and finding in most of them evidences of mixed or teratomatous structure, concluded that nearly all the cellular tumors are of embryonal and teratomatous origin. A specific exception is the rare adenoma of the testicular tubules, described by Chevassu and Pick, which they derived from the adult spermatic tubules. Pick's dictum of the one-sided development of teratomas, one anaplastic element outstripping and suppressing all the others, has found a rather wide application, and has done much to support the teratomatous origin of testicular tumors, especially of the benign growths. In 1911, one of the present writers, after a study of a series of testicular tumors was able to bring some additional evidence supporting the views of Wilms and Pick. In that study teratomatous elements were found in portions of some very early round-cell tumors. A peculiar lymphoid stroma was found to be characteristic of many embryonal tumors. Teratomatous features were found not only in the typical embryonal carcinoma with lymphoid stroma, but also in more adult tumors with fibrous stroma, the alveolar sarcoma of older writers. This latter tumor seems to be identical with the so-called seminoma of Chevassu, which that author believes to be derived from adult spermatoblasts. For these reasons, it seemed necessary at that time to admit that nearly all the malignant tumors of the testis are of embryonal teratomatous origin. The application of the theory of Wilms and Pick was thus somewhat extended. Since no one observer could assume that he had seen all the possible tumors of the testis, it was not claimed that rare malignant tumors of other types might not occur, but it was demanded that somewhat specific differences in the structure and clinical course of such rare tumors should be forthcoming before their exceptional character could be maintained.

The second view has been adopted by many French writers, especially by Chevassu. While recognizing the occurrence of many embryonal tumors with teratomatous elements, Chevassu maintains that the common round-cell tumor of the testis is derived from adult spermatoblasts and is neither embryonal nor teratomatous. He finds it possible to identify tumors arising, some from the inner and some from the outer, layers of cells lining the adult spermatic tubule. He was not able to trace the origin of any of these tumors to the spermatic tubules but bases the diagnosis on the resemblance of the tumor cells to the spermatoblasts. Clinical features separating the embryonal from the adult tumors were not observed.

Careful students of the recent literature will also discern a tendency to

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identify the two theories, by assuming an origin of many tumors from partly embryonal tubule cells distributed throughout the testis in normal tubules

A third hypothesis has sometimes been discussed, viz that the presence of a teratomatous tumor might excite a malignant tumor process in the adult tubule cells

Among recent writers the two main contending theories have enjoyed about equal popularity, but it does not appear that any new facts have been brought out which could decide the question at issue Recently, however, Gordon Bell has contributed an important study which favors the origin of certain tumors from the testicular tubules He points out that these tumors

generally occur in middle life grow more slowly than the embryonal tumors, and that transitional stages of transformation of normal into tumor tissue can apparently be traced We have never been able to trace such transformations in any of the malignant tumors, but have long been awaiting the observa-



FIG 1 —Gross appearance of multicystic tumor involving much of the body of testis

tion of a case in which it seemed possible, and in which other structural and clinical features suggested an origin of the tumor from adult cells The present case seems to have furnished the long desired opportunity

It might be supposed that a decision regarding the exact origin of testicular tumors is only of academic interest Yet, this view is not in accordance with certain facts, because most malignant testicular tumors carry a very bad prognosis, which determines certain lines of treatment based on course and outcome Moreover, most embryonal tumors are highly radiosensitive, and metastasize very early, while adult tumors may be expected to be less radiosensitive and to disseminate less early, so that surgical removal rather than radiation might be indicated

CASE HISTORY —Mr J M W, fifty-one years of age, weight 210 pounds, complained of some gastrointestinal disturbance for some months In June, 1926, first noted swelling of right testis Wassermann negative in blood and spinal fluid In right side of scrotum there was found a mass as large as a goose egg, with slight hydrocele On removal of

20 cc fluid the testis felt normal, but there was a small nodule at upper end and a larger smooth rounded mass at lower end, supposed to be in epididymis. On March 3, 1927, exploration under cocaine, showed the small mass to be in the globus major, while the larger mass was subsequently proven to be in the body of testis. On separating the epididymis, a large amount of clear fluid escaped from testis, and on pressure much more fluid escaped, reducing the size of the organ to nearly normal dimensions. The

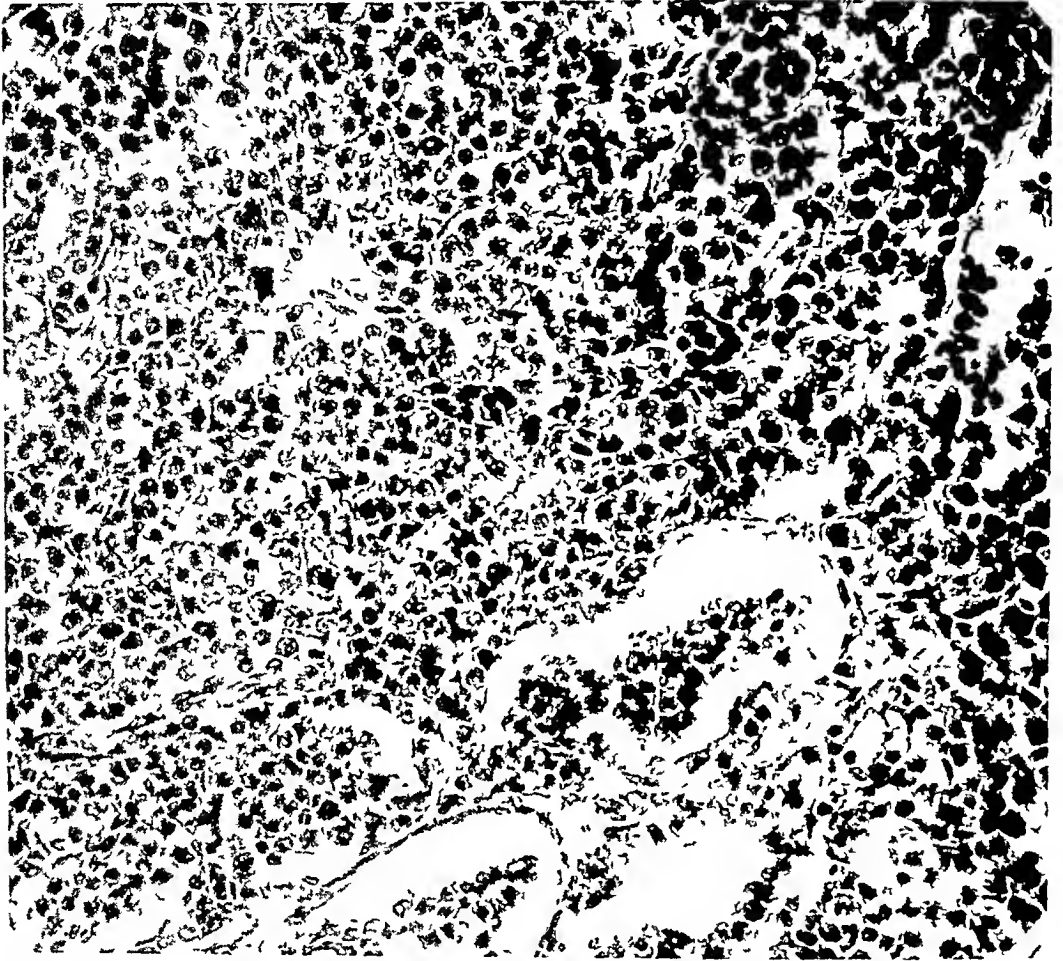


FIG 2—Structure of solid portion of tumor, showing diffuse or slightly alveolar growth of cuboidal cells

large mass had disappeared, but the testis in this region was thickened. Epididymectomy completed.

September 30, 1927, the testis was found as large as before, and was then removed with the spermatic cord.

At the present time the patient is well and there is no sign of local or abdominal recurrence.

Gross Anatomy—The testis, collapsed after drainage of fluid, measures 5 x 6 cm. The contour is rounded, smooth, tunica albuginea intact. On section, the tumor occupies about one-half of the glandular area, and mostly on one side, while the remaining half appears like normal testicular tissue. The upper half of the tumor resembles a very coarse sponge in texture, with extremely numerous fibrous strands inclosing very many small cysts. Some of the cysts are larger, 3 x 4 mm, and three are much larger, 1 cm in diameter. Among the cysts are several solid opaque tumor areas. The tumor is well separated from the gland tissue by a fibrous capsule along the upper segments, but, below, the cysts and solid tumor merge insensibly with the gland tissue. The tumor is thus distinctly within the body of the testis and not in the rete, where the usual carcinoma of

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the testis arises. The rete appears free from involvement. The epididymis, removed at the first operation, showed no definite gross changes. It was examined microscopically by Doctor Symmers, who reported Foreign body granuloma of epididymis.

The location within the body of the testis, and involving much of the organ, and the multicystic character, are features which distinguish the tumor sharply from the ordinary teratomatous carcinoma of this organ.

Histology—Histological examination by Dr. Symmers. "Foreign Body Granuloma

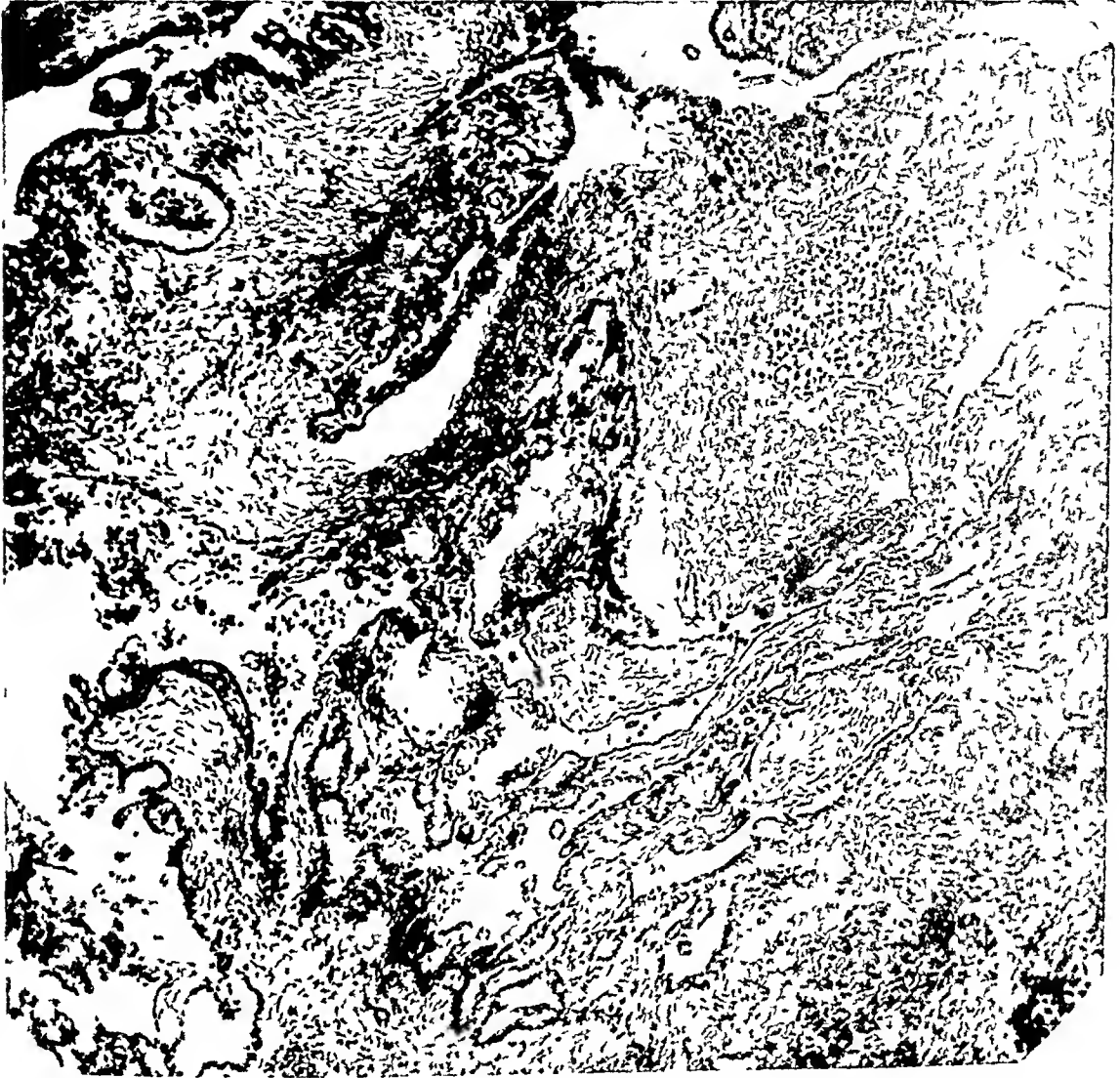


FIG. 3—Structure of area showing very many small cysts with papillary projections of stroma lined by flat cells.

of Epididymis." The structure of the tumor is peculiar and notably different from that of most testicular tumors. The cells are small, polyhedral, and very hyperchromatic, the nucleus filling most of the cell mass. They line the very numerous small cystic spaces in single rows or flat layers. There are numerous papillary projections of stroma in the cysts, all covered with one or more layers of epithelial cells, and these cells sometimes infiltrate the stroma. The tumor cells also form solid areas, in a diffuse or slightly alveolar structure. The stroma is adult in type and free from lymphocytic infiltration.

The remaining testicular tubules are atrophic, but many of them are filled with tumor cells. Spermatozoa are found in considerable numbers in many tubules, which are slightly altered. In places the lining cells appear very hyperchromatic and atypical, suggesting that they are in process of transformation into tumor cells, but the derivation of the tumor from the tubule cells is not satisfactorily accomplished. It is possible that the suspicious tubules are being invaded by tumor cells from without. The tumor mass seems to replace rather than compress and displace the testicular tissue. In this

respect the process is entirely different from the teratomatous carcinoma, which displaces and compresses the testis, and only occasionally invades it

The general structure resembles that of the adenomas of Pick and Chevassu, but is much more cellular and anaplastic than these adenomas

COMMENT

The present case presents clinical, gross anatomical, and histological features which separate it sharply from the common embryonal tumor of the testis. The age of the patient, fifty-one years, the slow course, and the absence of metastases after a long period, and in spite of a partial operation, indicate a different clinical condition from that which exists with the malignant embryonal tumors. The gross anatomy, showing a peculiar multicystic tumor arising well within the body of the testis and replacing the gland tissue instead of displacing it, is very different from that of the embryonal tumors. The structure marked by small cubical cells covering very numerous papillary projections of stroma and growing in diffuse or slightly alveolar form, is also markedly different from that of the embryonal tumors.

We therefore conclude that the tumor is not to be classed with the ordinary embryonal tumors of teratomatous origin, but is an adult anaplastic growth probably derived from the adult tubule cells.

We have never seen a tumor of exactly this type before, and therefore think they must be rare. Gordon Bell, however, describes four cases, three of which at least seem to belong in the present class of adult adenocarcinoma. They all occurred in subjects past the usual age of incidence of testicular tumors, and they grew slowly, remaining in the testis for as long as two and three years. The fate of the patients was not stated.

In view of all the data now available, it appears that there are two varieties of malignant carcinomas of the testis. The great majority, but not all of the tumors, are embryonal carcinomas of teratoid origin, which tend to appear at earlier ages, generally before forty years, grow rapidly, metastasize freely by both blood and lymph paths, and are highly radiosensitive. The other type is rare, appears generally after forty years of age, grows slowly, metastasizes less rapidly, is probably somewhat radioresistant, and should offer a better prognosis.

It should be possible to recognize many of these cases of slowly growing tumors of adult type on clinical data, and many more, if not all, should be identified on gross anatomical and histological features. It still remains to determine how numerous these tumors are, and whether there are other variants of the series of adult adenocarcinomas which can be separated from the embryonal carcinomas.

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CARCINOMA OF THE TESTICLE

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Historical Data—The earliest record of an attempt to study the nature of testicular tumors of probable malignant character is found in the work of Saint Donat. In 1696 he identified in a neoplasm from that site a rudimentary skull and pigmented ocular cups, and thus seems to have established in great measure the teratomatous origin of these tumors. In 1803 Prochaska found fetal units in a testicular neoplasm of malignant nature and in 1833 André de Peronne discovered hair, teeth and bones in a similar type of new growth. Later Johnsen established the tridermal character of malignant tumors of the testicle, and the investigations of Carling went far to demonstrate that their probable beginning is in the rete testis.

Frequency—Tumors of the testicle are relatively rare. The great majority of them are malignant. Benign neoplasms are so rare that they are of very little clinical importance. Only a very small number of the different types of benign tumors are on record. Ewing¹ recognizes only two true adenomas of the testicle, and Rubaschow² collected three rhabdomyomas, two osteomas, one lipoma, ten fibromas from the literature and noted that enchondromas and hyaline nephromas are extremely rare. Among the malignant testicular neoplasms which represent 1-3 per cent of all malignant tumors encountered in the human body (Bouchard and Laquiere,³ Weiser,⁴ Morris⁵), the carcinomas are by far more frequent than the sarcomas. Only 4-10 per cent of all testicular tumors are sarcomas. Rubaschow² mentions in his recent communication thirteen round-cell sarcomas, seven spindle-cell sarcomas and four polymorphous-cell sarcomas as reported in the literature. Endotheliomas are very rare. Tanner⁶ collected in 1922 about 600 cases of testicular carcinomas from the literature. The present number of published cases runs well over 700. Besides true tumors, teratomas and teratoids are found in the testicle from which benign as well as malignant tumors frequently arise. These formations can be arranged according to their frequency as follows: Carcinomas, teratoids, teratomas, sarcomas and benign tumors.

Etiology—1. Heredity does not play an important part in the etiology of testicular carcinomas (Wesson⁷).

2. Sexual activity may have some relation to the origin of these tumors as they occur most frequently during the period of the greatest vigor.

3 Previous testicular or epididymic diseases as tuberculosis, gonorrhœa, syphilis, are apparently without any etiological significance (Weiser⁴) tory in 20-30 per cent of the cases (Wesson,⁷ Coley⁸) Chevassu⁹ states

4 Trauma is of a doubtful causative importance in spite of a positive histology that it is overrated as an etiological factor and Weiser⁴ takes a similar standpoint in this matter. It has to be considered that trauma of the testicle is very common. By directing the attention of the patient to this organ the trauma may cause the detection of the preëxisting tumor. But in cases in which the development of a tumor follows the trauma several months later a relation between trauma and tumor formation cannot be absolutely denied, as testicular carcinomas grow rather slowly in the beginning. The more frequent occurrence of carcinomas in undescended testicles located in the inguinal canal is also mentioned in support of the etiological significance of the traumatic factor. It is asserted that the inguinal testis is subjected to frequent bruising against the pubic bone and compression by the contraction of the muscles of the anterior abdominal wall. But Weiser⁴ contends that the inguinal testicle is less exposed to trauma than the scrotal organ. It is, however, a fact that inguinal testes are more frequently the seat of carcinomas than the scrotal ones. While carcinomas are ten and three-tenths times as often present in scrotal testes as in inguinal ones (Pearlman,¹⁰ Cunningham¹¹), only one undescended testicle is found to 500 scrotal ones, or malignancy in undescended testicles is fifty times as frequent as in scrotal ones. Rice¹² states a lower figure (1:15), but there is still a marked predominance of the carcinomas in the undescended organ. Trauma as represented by the contraction of the abdominal muscle occurring with coughing, lifting, etc. (Kahlden¹³), or torsion of the cord (Pearlman¹⁰), is regarded as a causative factor for the development of malignancy in testicles retained in the abdomen. Bulkley¹⁴ notes that one in every seventy-five abdominal testicles becomes malignant, or one in every four malignancies in undescended testicles is found in an abdominal one. Uffreduzzi¹⁵ and Keyes assert also that the abdominal testis is more likely to become malignant than the testis retained in the inguinal canal. Tanner,⁶ however, states that the testis located in the abdomen has the least tendency toward malignancy. Wesson⁷ and Keyes¹⁷ regard the present statistical data concerning the frequency of malignancy in abdominal testicles as inconclusive. Pearlman¹⁰ collected sixty-five cases of malignancy in abdominal testicles from the literature.

5 The importance of developmental disturbances of the testicle for the origin of cancers of the testicle is especially emphasized by Ewing,¹ Pick,¹⁸ Wilms,¹⁹ Ribbert²⁰ and others. Ewing contends that all carcinomas as well as the majority of other testicular neoplasms derive from teratoids which are highly potentially malignant. In these teratoids the tumor cells outgrow and suppress more or less the other tissue elements. Weiser⁴ also stresses the importance of this factor. He states that the affected testicle is often congenitally larger or smaller than the normal one, pointing to

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the presence of developmental disturbances in this organ. He holds also that the increased frequency of cancer in undescended testicles supports this viewpoint. Furthermore the occurrence of malignant growths in both testicles is highly suggestive of the existence and causative significance of pathological developmental conditions in these organs. Bland-Sutton²¹ mentions in 1923 that thirty-five cases of malignancy in both testicles were so far reported. Trauma probably may act as a contributory factor by activating the latent proliferative qualities of congenitally pathologic cells.

Origin—Carcinomas usually start in the rete testis in the region of the junction of the upper part of the epididymis with the back of the testis. There exist two theories concerning the actual origin of testicular carcinomas. Langhans²² suspected and later Ewing, Wilms and others considered it a well established fact that testicular carcinomas are exclusively products of a one-sided development of teratoids. Ewing claims that a careful examination of the tumor frequently shows at times only very scanty traces of other tissues as cartilage, bone, nests of entodermal epithelium, etc., revealing the teratoid origin of the tumor (Morris,⁵ Hinman, Gibson and Kutzmann²³). Ewing supports his contention with the following reasons:

- 1 The characteristic structure of embryonal carcinomas is sometimes also observed in carcinomas of definitely teratoid origin.

- 2 He observed in a very early embryonal carcinoma minute traces of other tissues.

- 3 The rapid growth of the malignant embryonal elements gives unusually favorable opportunity for the overgrowth and suppression of other tissue elements.

- 4 The only known benign tumor of the adult spermatoblasts is very different from the embryonal carcinoma.

- 5 Against the origin of the embryonal carcinomas from spermatoblasts incited to growth by the presence of a teratoma the occurrence of extratesticular embryonal carcinomas (ovarian teratomas) (Zeitlin²⁴) has to be noted.

- 6 He could not substantiate the findings of Gordon Bell²⁵ who reported the observation of transitional stages between normal spermatoblasts into tumor cells as he was unable to rule out collateral hyperplasia and invasion of the tubules by tumor cells.

- 7 There does not exist an actual difference between the origin of embryonal carcinomas from primordial isolated blastomeric cells and primitive sex cells as both are omnipotent.

Chevassu,⁹ Debarnard,²⁶ Schultz and Eisendrath,²⁷ Gordon Bell,²⁵ Frank,²⁸ Geist²⁹ and others, however, claim that a certain type of carcinoma which Chevassu named seminoma, Ewing called embryonal carcinoma. Schultz and Eisendrath termed spermatocytoma, originates from the adult spermatoblasts of the testicular tubules. They assert that the teratoid character of embryonal carcinomas is not evident in the majority of the cases, that these tumors may occur associated with teratomas and that the differ-

ence in the age of incidence of seminomas and teratoid carcinomas, the former being more frequent in the third decade, while the latter are more frequently found in persons who are in their fourth decade, but also occur in babies as well as in old persons, point to a difference in character of these two new growths. Ewing admits the possibility that those clear celled carcinomas tending to form alveoli without definite embryonal character and without lymphoid stroma may belong into a separate class and originate from adult tubular epithelium as claimed by Chevassu. He concludes that in no other organ the principle of overgrowth of one element of a teratoma has been proved to be so predominant as in those of the testicle and while it is possible to carry this principle too far, the data seem to demonstrate its great importance in the interpretation of tumors of this region. Ewing does not completely deny according to this reference the origin of a certain type of testicular carcinomas from the tubular epithelium. Seminomas may originate, from an evaluation of the existing observations in our opinion, from teratoids as well as from the testicular epithelium. But the latter tissue is apparently less frequently the source of malignancy of the testis. There seems to us not sufficient evidence brought forward to deny to spermatoblasts any malignant blastogenic properties. Kaufmann³⁰ considers also the origin of testicular carcinomas from adenomas and germinal parts of Wolff's body.

Macroscopic Appearance—The testicular carcinomas can be divided according to their macroscopical appearance into solid and cystic carcinomas.

1 Solid carcinomas are usually soft, rarely firm in consistency. The normal shape of the organ is usually preserved, but also a nodular surface may be occasionally seen. The testis is in general considerably enlarged in cellular tumors or may be rarely of almost normal size in fibrotic neoplasms of scirrhous type. On the cut surface they are often turbid, of yellowish white color and medullary, homogeneous, sometimes somewhat granular or glassy gray appearance without any definite texture. Hemorrhages and irregularly shaped yellow necroses which are frequently very extensive may produce a multicolored aspect of the cut surface. Atrophic testicular tissue may be present in the periphery of the tumor underneath the capsule.

2 Cystocarcinomas resemble multicystic cystadenocarcinomas or cystic teratomas of the ovary. But they involve also the epididymis which remains unaffected in teratomas of the testicle.

The epididymis is in general completely absorbed in the tumor mass. The time of invasion of this organ depends upon the size, the location and proliferative activity of the tumor. The tunica albuginea is rarely involved except in a late stage. The veins in the tunica albuginea are dilated and tortuous. Perforation through the skin with ulceration and suppuration is rare.

Microscopical Appearance—The testicular carcinomas may be grouped according to their histological structure as follows.

1 Seminoma or spermatocytoma or embryonal carcinoma or incorrectly large round-cell sarcoma. 2 Adenocarcinoma with its papillary and gelatinous variety. 3 Squamous-cell carcinoma with and without cornifications and basal-cell carcinoma. 4 Neuroepithelioma. 5 Chorioepithelioma. 6 Carcinosarcoma.

1 Seminomas which constitute about 50 per cent of the malignant testicular tumors are composed of solid nests of round or polygonal, large cells with a clear, glycogen containing cytoplasm and large, round, usually centrally located, hyperchromatic nuclei.

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They are in general arranged in smaller and larger alveolar or tubular formations which may rarely show a central lumen and are embedded in an interlacing network of loose connective tissue containing more or less numerous lymphocytes. Even definite lymph nodes may sometimes be present. Extensive necroses and hæmorrhages are frequently observed. The stroma is sometimes more abundant, the alveolar arrangement less pronounced and a more diffuse infiltrative proliferation of the tumor cells exists. In rare cases the lymphocytic infiltration is absent. The seminoma cells are highly sensitive to fixation fluids. If the tissue is not properly treated the cells shrink leaving a pseudointercellular substance. Other tissue elements as bone, cartilage, nervous cells, etc., pointing to a teratoid origin of the tumor are not infrequently found.

2 Adenocarcinomas are not as often observed as seminomas. Gelatinous adenocarcinomas are extremely rare. Papillary and solid formations are sometimes present in the same tumor. The adenocarcinomas show frequently a very delicate structure. They are found in very young as well as very old persons.

3 Squamous-cell and basal-cell carcinomas are rarely seen. The cornified type of squamous-cell carcinoma is very rare.

4 Carcinoma of a neuroepithelioma type are also very rarely observed. In these tumors oval and spindle-shaped cells surround in a radiating arrangement a small central lumen.

5 Chorioepitheliomas representing the typical or atypical syncytial type are rare. They are sometimes associated with embryonal adenocarcinoma. The primary tumor which appears as a dark red nodule is occasionally very small and may be overlooked during life time. Spontaneous regression of a testicular chorioepithelioma is suspected in cases in which a fibrous node in the testicle and extensive general metastases of a chorioepithelioma exist.

Metastases—Carcinomas of the testicle form in general, very early and extensive metastases by way of the lymphatics and blood vessels. The vas deferens is rarely invaded and used as a way for the extension of the tumor. Very small testicular tumors which cannot be palpated may produce retroperitoneal metastases of enormous size (Prym³¹). By continuous growth in the lymphatics of the spermatic vessels the tumor cells may surround, compress and even invade the ureter and urinary bladder and infiltrate the perivascular tissue from the inguinal canal up to the renal hilum. By invasion of the spermatic veins the tumor cells may grow into the inferior vena cava and the right heart. Metastases by way of the blood vessels are found in the lung, liver, brain, kidney, etc. The metastasizing in the lymphatics occurs in two steps. The retroperitoneal lymph nodes located before the 3rd–4th lumbar vertebræ, left of the aorta and right between aorta and vena cava are first involved. They appear on palpation as unmovable masses which may bulge sometimes below the costal arch. After the perforation of the tumor cells into the thoracic duct metastases are observed in the left supraclavicular lymph nodes. From there the tumor spreads into the intrathoracic lymph nodes and by way of the blood into other organs. In carcinomas having the structure of a mixed tumor the metastases may reproduce the different tissue elements of the original tumor. Cylindrical-cell carcinomas sometimes form metastases after several years of latency.

Symptoms—Malignant tumors of the testicle present very little in the way of subjective symptoms, especially in the early stage or before metastases have occurred. Pain is present in somewhat less than one-third of all cases.

but it is not severe. It is, rather, of a dull, aching and dragging character, more noticeable toward the end of the day. It almost invariably disappears after a few hours in the reclining posture and is probably due to blood vessel engorgement and the pull of the increasing weight of the tumor. Objectively there is not much more. The tumor grows slowly at first and then rapidly, retains in most cases the normal oval outlines of the testicle, is generally smooth and moderately firm on touch and seldom involves the skin and fascia. The cord is not always thickened.

The secondary growths may be attended by symptoms peculiar to their respective localities. Pain and tenderness on palpation of the mass or masses are characteristic of metastases in the skeleton, especially in the cranium. Digestive disturbances and sometimes constipation are not infrequently noted when the retroperitoneal glands in the region of the celiac axis are involved. When, rarely, the brain is attacked there are characteristic findings of pressure, and when the lungs are invaded, or the thoracic glands, a rather persistent and annoying cough is likely to trouble the patient. Signs and symptoms of intestinal obstruction are sometimes met with when there are formed adhesions between the secondary growths and the small bowels in the upper abdomen. Hematuria and other urinary disturbances as tenesmus occur when the kidney is invaded or when the bladder is subject to pressure from growths, primary or secondary, in the lower abdomen or pelvis. Skin metastases are seldom painful and may escape unnoticed by patient and physician. They resemble sebaceous cysts and are frequently discolored.

In most cases, following early metastases, cachexia and loss of weight and strength appear, indicating that the inevitable outcome is not far away.

In the intraabdominal type, vague and, for the most part, ill-defined symptoms of pressure pain in the lower portion, followed later by the discovery of the tumor or tumors (in the bi-lateral cases) on examination constitute the principal findings.

Diagnosis—This is usually not very difficult if the possibility of cancer is kept always in mind when examining enlargement of the testicle.

The differential diagnosis is probably seldom made, clinically, and if done, could have little if any bearing on the treatment or outcome.

There must be differentiated, however, the following conditions:

1 Inflammations a Orchitis, simple, traumatic b Orchitis and epididymitis, gonorrhœal c Gumma d Tuberculosis e Hydrocele f Hematocele (traumatic)

2 Neoplasms (testicle and epididymis) a Benign tumors (adenoma, fibroma, osteoma, lipoma, enchondroma, etc.) b Malignant tumors I Primary malignant tumors (sarcomas) II Secondary malignant tumors (sarcomas and carcinomas)

3 Teratomas and teratoids

ORCHITIS This is generally co-incident with gonorrhœa or follows very shortly after trauma. There is greater pain and tenderness than in carcinoma.

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Increase in size is more rapid, generally a matter of hours or at most a day or two from the onset. There is more irregularity in outline of the mass and the epididymis is distinguishable.

GUMMA Here a Wassermann test alone cannot be relied on, as a coincident syphilis and carcinoma might exist. Vigorous antisyphilitic therapy for a week's duration should cause the gumma to shrink to such a proportion as to establish its nature. Here also its irregularity in shape together with the probable identification of the epididymis as a separate mass should assist in the differentiation.

TUBERCULOSIS A nodular, irregular tumor mass involving the testicle, epididymis and cord, together with a rise in temperature, especially in the afternoon, and the probable finding of evidences of tuberculosis elsewhere, quite likely in the seminal vesicles or in the pulmonary organs, should render the diagnosis not exceedingly difficult.

HYDROCELE Transillumination should always be used when hydrocele is suspected. Sometimes the fluid is quite thick and translucency is not apparent. An exploratory incision may be necessary to clear up the situation. A hydrocele may, however, co-exist with tumor.

HEMATOCELE This generally follows trauma after a short interval. The tumor cannot be transilluminated and is a boggy, not very firm mass. Here again an incision may be necessary to determine the nature of the tumor. If the blood is clotted or the clot has become organized, aspiration is useless. In hematocele, of large size, practically none of the structures on the side of the scrotum involved, can be identified. In those cases due to trauma, ecchymosis of the surrounding skin will likely be present. Where it is due to other causes, this, of course, will not be found.

BENIGN TUMORS This condition is not commonly met with, at least when compared to malignancy of the testicle. The tumor would be of slow growth, obviously it would produce no metastases nor have any detrimental effect on general body health. Removal of the tumor and microscopic examination will establish its nature.

SECONDARY MALIGNANT TUMORS These are very rare. The presence of the primary tumor and metastases in other organs will usually assure the correct diagnosis.

EPIDIDYMIC TUMORS, benign as well as malignant ones, are extremely rare. The testicle can be palpated and distinguished from the epididymis (Scholl³⁴).

TERATOMAS They are in general nodular, slowly growing masses which do not involve the epididymis. Bony and cartilage tissue may be sometimes demonstrated in the tumor by a Röntgen-ray picture.

The differential diagnosis of carcinomas of the intraabdominal testicle needs special mention. Renal, intestinal tumors and those of the urinary bladder have to be considered. By Röntgen-ray examination of the respective organs the correct diagnosis will be obtained.

Malignant tumors of the testicle have many characteristics which would seem to be distinctive. They grow rapidly, once active, and definite increase in size has been noted. They are generally quite regular in outline and obliterate all of the usual distinctive markings on the side of the scrotum involved. They are usually without nodulation and for the most part firmer and harder than the benign or inflammatory growths. In doubtful cases, and they are all that to a certain extent, there should be no hesitancy in making an immediate exploratory incision and in removing, if need be, the tumor for detailed examination to establish its nature. Waiting for further developments in suspected cases is not only needless but may easily render all future therapeutic measures futile.

Treatment—The treatment is essentially surgical and operative, supplemented frequently by deep Rontgen-ray therapy, radium application and in some instances (Coley) mixed vaccines.

The surgical procedures employed vary from simple castration to an extremely radical operation which aims at the removal of inguinal and retroperitoneal lymph nodes and in some instances the spermatic vessels.

Statistics on the results obtained from the employment of these measures, single or in continuation, show a wide range of variation. Regardless of method employed, it is generally conceded that early operation offers the only hope to the patient.

When simple castration alone is used it has been pointed out that the cord must be very carefully separated from the surrounding tissue and severed as high up in the inguinal canal as possible before the testicular tumor is handled in any way to avoid, it is contended, the spread of embolic particles into the circulation. It is asserted by many surgeons that castration in malignant tumor of the testicle is without therapeutic value.

A much more radical operation for the relief of the condition, suggested by Chevassu and employed rather extensively also by Wesson as well, consists in castration, as described above, together with the spermatic vessels with all the tissue (gland bearing) surrounding these vessels as well as that between them and the large abdominal vessels, including the lumbar lymph nodes. All this is removed in one mass, retroperitoneally, through an incision which extends from the scrotum to a point in the groin opposite the umbilicus. The peritoneal cavity is not opened. This operation is quite difficult, especially that portion of it which aims at the removal of the lumbar lymph nodes, and, in addition, has an immediate mortality rate of 10 per cent (Chevassu) and 12.4 per cent (Wesson). The latter and Cairns recommend it as the best procedure. It appears to us, however, in view of the fact that earlier metastases occur in glands much higher up than those removed in the procedure just described, that this operation cannot be considered, logically, as having a curative value. That, however, is a matter of individual opinion.

Rontgen-ray treatment, first employed by Beclere¹⁶ and used later by Zeitlin, Prym, Keyes, Weiser and others, with apparently highly satisfactory

results, must be mentioned. The technic consists in pre-operative irradiation of the testicle with low voltage and post-operative high voltage irradiation of the abdominal glands. Weiser, however, thinks that this is not sufficient to prevent metastases or to check them in the abdominal lymph glands. Wesson takes a somewhat opposite viewpoint in that he believes that irradiation of the abdominal lymph glands is of value in checking metastases there, even from seminomas.

It would appear that there is a logical prophylactic phase which might be considered in dealing with the subject of malignancy in the undescended testicle. On account of the increased incidence of and the proneness to malignancy in the undescended testicle especially when it lies in the inguinal canal, it would seem that many of them, especially in adults, might well be removed before tumor forms. This has long been our opinion and has frequently guided us in the management of uncomplicated undescended testicle.

Pearlman is not of this opinion, apparently, and especially advises against interference in abdominal testicle. Weiser, on the other hand, recommends the removal of undescended testicles if orchidopexy is not possible.

Undescended testicles in the adult human are nearly always aspermatic and spermatogenesis does not occur in the vast number of these in spite of the presence of mature germinal cells. Thus, in our opinion, there exists no valid reason for the retention, in the body, of these potentially malignant organs in view of the fact that endocrine disturbances cannot result from their removal so long as one functioning testicle is left.

Prognosis—The prognosis in testicular carcinomas is not good, to say the least. It depends, largely, upon the location, extension of the tumor and its probable early and undiscoverable metastases, and in no small measure, upon its histologic type. Malignant mixed tumors offer a worse prognosis than pure tumors. Carcinomas in cryptorchid testes are usually inoperable and thus offer little hope. These cases with abdominal metastases have very little chance for recovery. Recurrent testicular carcinomas are always fatal and characterized by a notably rapid course.

Chevassu states that he saw no case die after the lapse of three years immunity, following operation. Other observers report the occurrence of metastases many years after removal of the primary tumor and these, in general, proved fatal. Great variations are observed in the percentages of cures obtained by the different authors.

Weiser obtained 24 per cent of cures after castration, Hinman 15 per cent after castration and 30 per cent of cures after radical operation, Handfield-Jones, 59 per cent, Rice, 46.5 per cent in 144 cases (1899), Kober (1899) 8.17 per cent in 144 cases, Chevassu (1906) 19 per cent in 103 cases, Bulkley (1913) 5 per cent in sixty cases, Codman and Sheldon (1914) 41 per cent, Crowley and Martland (1919) 50 per cent in thirteen cases and Coley (1915) 28 per cent. The post-operative life in malignant tumors of the testicle is, according to Rice 8.35 months.

ILLUSTRATIVE CASES

CASE I—J C, age thirty-three years, by occupation a truck foreman, entered Mercy Hospital March 2, 1928. He stated that he had come for an operation for the relief of a left-sided hydrocele.

He gave the following history: With the exception of an uncomplicated urethritis of short duration five years ago he had not at any time been seriously ill. He is married and has one infant child, living and well. His wife has had no miscarriages. In July, 1926, while inspecting the top of a truck, he slipped and fell, striking astride a steel ledge which ran along the bottom of the body of the vehicle. He experienced immediately severe pain in the left testicle but that was of short duration. During

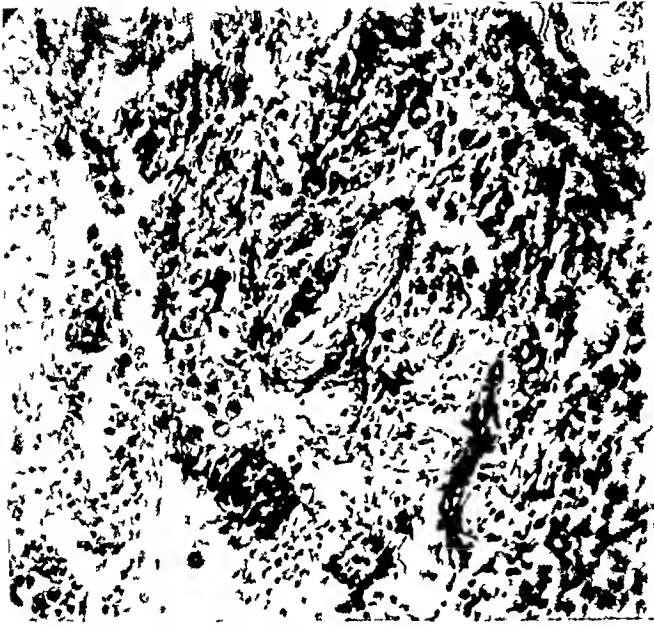


FIG. 1.—Case I.—Diffuse infiltration of pencil cells into the nest of seminoma cells.

the next three days nothing of consequence occurred, but at the expiration of that time he noticed that the testicle was swollen but not painful. He thought that it was about twice normal size. He consulted a physician who prescribed some sort of lotion which the patient says reduced the swelling. He did not go to bed at this time but continued to do his work as usual.

About nine months later he began to observe a dull aching pain in the left testicle which increased gradually in severity and was always more pronounced at the end of the day and which, invariably disappeared after lying down for an hour or two. He stated that there was no apparent enlargement of the testicle at this

time but that it was appreciably harder. Very soon after this the mass in the scrotum began to increase in size, rather rapidly, reaching its peak in growth in February, 1928, at which time it had attained the proportions of a large egg. The character of the pain was still not severe but dull and aching. He had experienced no feeling of diminished health or strength.

A regional examination revealed an oval-shaped, fairly firm mass in the left side of the scrotum about the size of a goose egg. It was very smooth and not in any way irregular or nodulated, nor was it adherent to skin or fascia. The epididymis was not seen nor could it be palpated. There were no glandular enlargements in the inguinal region and the cord was not appreciably thickened. The mass could not be transilluminated, but neither can every tumor containing fluid. Pulse and temperature were normal and urinary findings were negative. A rectal examination was not made. A diagnosis of hydrocele, with probably thickened fluid, was made. As a purely precautionary measure it was suggested to the patient and his family that the mass might be a tumor and permission to remove it, if deemed advisable, at the time of operation, was obtained.

March 5, under a general anæsthesia, the skin and superficial tissues were opened in the usual manner and the mass was delivered. It was seen at once that the condition was not hydrocele. A stab wound with a small scalpel permitted the escape of a thin bloody fluid. The wound in the tumor was enlarged and the interior inspected. This showed it to be a solid mass, grayish-red in some places, grayish-yellow in others.

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There were areas of necroses and hæmorrhagic spots. It was removed together with the cord, the latter as high up as it could be done. The wound was closed without drainage. The wound healed by primary intention and the patient went home in ten days.

Pathological Report—The testicle is 11.0 cm long and 7.0 cm wide, of oval shape and smooth surface. The organ is surrounded by a markedly thickened connective tissue capsule, which contains numerous diffuse hæmorrhages on the inside and which is adherent to the tumor in places. There is not a trace of testicular tissue or epididymis present as evident from an inspection of the cut surface. The tumor consists of nodes varying in size from that of a pea to that of a large walnut. They are separated from each other by a strong, white connective tissue stroma. Some are yellowish-white and of a homogeneous, bacon-like appearance, others more grayish, medullary, while the majority contains extensive hæmorrhagic parts and is of a granular or small cystic structure. The tunica vaginalis is invaded by the tumor tissue where adhesions exist.

The tumor is microscopically composed of very large solid areas of large, round, clear cells with large, round, deeply stained nuclei. Mitoses are numerous. Diffuse infiltrations of the tumor cells into the stroma are frequently seen. Necroses and hæmorrhages are numerous and extensive. Slender,

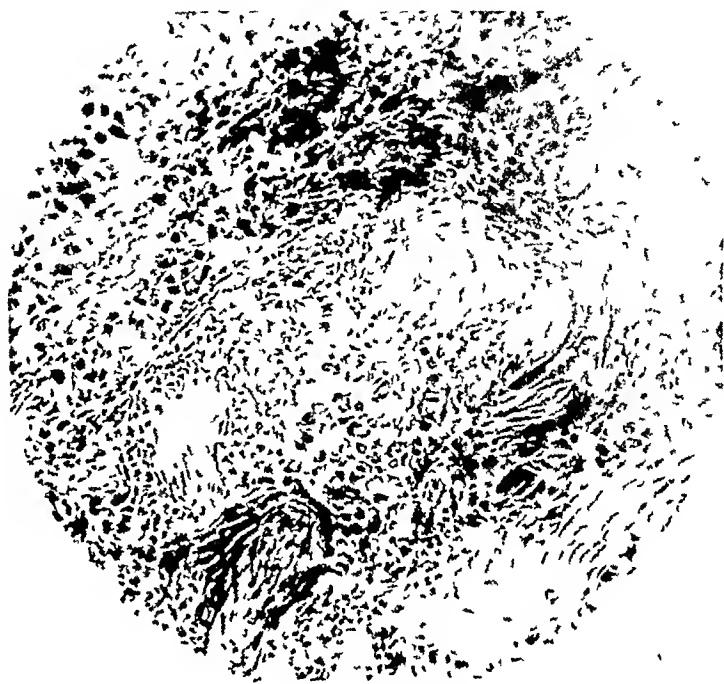


FIG. 2—Strands of pencil cells surrounding a degenerated centre of seminoma cells

spindle-shaped or oval cells with elongated, spindle-shaped, hyperchromatic nuclei and a small amount of cytoplasm, either pointed on both ends or thickened on that end which points to the periphery of the carcinomatous cell nest. These cells invade the carcinomatous pegs from the periphery, being radially arranged, forming sometimes nets and splitting up the solid masses of carcinoma cells. In other places they crowd the centre of the strands where necrosis of carcinoma cells is present. These cells are apparently identical with the "pencil-cells" described by Lahm³² in carcinomas of the uterine cervix. According to Lahm their presence indicates an attempt of the tumor toward a spontaneous cure. Hueper³³ could substantiate this assertion to that extent that cervical carcinomas which contain numerous pencil-cells show in general a better prognosis than those in which these cells are absent. The stroma of the tumor is fibrous and contains a moderate number of lymphocytes. The capillaries and smaller veins are often filled with solid plugs of carcinoma cells. In one of the numerous blocks examined, several small islands of bony tissue were seen in the stroma. An examination of the resected end of the cord revealed the presence of small nests of carcinoma cells in the pericardial tissue.

Diagnosis—Seminoma originating from a teratoid.

Subsequent Findings—The patient returned to light work four weeks following his operation. Four days later, while driving a truck, he developed a painless hæmaturia intermittently for several days, during which time he passed several small worm-like clots which were inspected and which appeared to be ureteral casts. He was cystoscoped by a competent urologist whose findings and report were as follows:

The veins of the trigone of the left side are rather prominent. The left ureteral orifice is pathological in that it appears as though it were elevated by something under the mucous membrane, which begins at the upper margin of the ureteral opening and is about the size of a large pea. The right ureteral orifice and the right half of the trigone are normal. Rest of the bladder is normal. There is no pulsation in the swelling, no movement. This gives a small shadow. It might be well later to remove this for histological study. Blood count: whites 8,200, hæmoglobin 95 per cent. Blood pressure 140/88. Examination of the urine on admission showed no sugar, no albumin, blood, and many red blood cells in centrifuged specimen. A specimen on the day following cystoscopy showed two+ albumen and many red blood cells. Catheterization of the

ureters. No urine obtained from the left side. Right urine was free of pus, sterile upon culture and negative for tubercle bacilli. Bladder urine showed 50 pus cells and was sterile upon culture.

X-Ray and Pyelograms—Right kidney outline normal, left not made out. Catheter on the right to top of third lumbar, on the left overlying the top of sacro-iliac. Overlying the upper end of left catheter is dense oval shadow, 7 mm by 10 mm. This shadow can be seen on three films and strongly suggests stone. Injection of left catheter shows a normal filling up to this density but practically none of the pyelogram solution extending beyond it. Considerable of the solution has returned to the bladder. Right pyelogram shows kidney pelvis at the second lumbar, negative. Slight dilatation of the ureter at the level

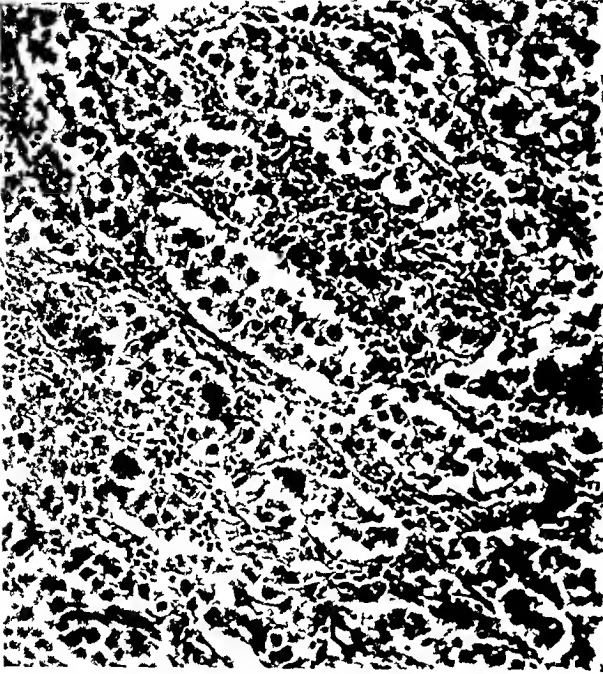


FIG 3—Case II—Clear seminoma cells in alveolar arrangement imbedded in a lymphoid stroma

of the fifth lumbar, otherwise pyelogram is negative. Some solution has returned to the bladder, particularly after the injection of left side. One line of this is curved with concavity downward. The lower border is sharply defined, the upper border not so well defined. This may be a second fluid level in the bladder because the bladder is pressed upon from behind by large prostate. The lower part of bladder shadow is more or less concave which also may be due to prostatic pressure. I think the essential pathology is that of stone in the lower end of the left ureter which is making complete obstruction. Beginning about May 1 he was given, on the advice of the urologist, for fifteen minutes, twice weekly, deep X-ray treatments in the region of the left loin and left kidney. The hematuria stopped immediately and had not reappeared on July 31.

He was examined on July 31, or about five months after initial operation. He felt, he said, well and strong and was of normal weight, 194 pounds. He had lost sixteen pounds during and just after his attack of hematuria but this had all been regained. There were two rather hard and somewhat irregularly oval shaped masses, close together but easily distinguishable, each about the size of a small olive, near the left external inguinal ring—undoubtedly local recurrences. In the left supra-clavicular space there was a group of enlarged lymph nodes, slightly adherent to the underlying structure and about the size of half a small apple, no doubt metastases. Other findings were negative.

An examination made August 3 revealed nothing new.

CARCINOMA OF THE TESTICLE

August 10 he again appeared for examination. He had lost two pounds. Hematuria had returned, though it is not constant, there is some vaginal disturbance and a slight cough but no hemoptysis. He says he feels well and easily. There are some inguinal glands palpable on the right side and the tumor, not seen before, under the skin of the back. This represents progressive static growth. It resembles a sebaceous cyst and has a slightly bluish tint. It is not painful nor tender.

CASE II—Man, forty-three years old, was operated on ten years ago for inguinal hernia which recurred three years later. The right testicle became hard, tender and irregular in shape after operation and an abscess formed and ruptured. Two weeks ago the right testicle started to swell again. Pain was continuously present in the organ. He was admitted to Mercy Hospital October 14, 1927, and subjected to removal of the testicle and high ligation and resection of the cord. Massive adhesions in the inguinal region originating from the previous herniotomy prevented further exploration into this area.

Pathological Report—The testicle is 7.5 cm long and 3.5 cm wide. The normal shape of the testicle is well preserved. The surface is smooth and the tumor very much is not adherent. On the cut surface multiple nodular formations of yellowish color and bacon-like appearance or of more grayish-white color and delicate granular structure are seen. Epididymic tissue is not present at the lower pole. At the upper pole of the tumor a bean-sized nodule of light brownish color and distinctly small follicular structure is observed. In one of the more centrally located tumor nodes a large, irregular, yellow necrosis is present. The lumen of the cord is plugged by a yellowish, homogeneous mass.

Microscopic Examination—The tumor has an alveolar structure and is composed of smaller and larger solid, well demarcated nests and strands of large, usually round, sometimes more polygonal vesicular cells with large round, distinctly stained nuclei. Mitoses are frequent. The loose connective tissue stroma forms a delicate network in which numerous lymphocytes are embedded. There are large necrotic areas. In some of the carcinomatous cell nests the tumor cells are apparently arranged around a small central lumen. The node with follicular structure present at the upper pole presents normal epididymic tissue with some dilatation of duct. In spite of the examination of numerous sections taken from various portions of the tumor no evidence of other tissues could be detected. **Diagnosis**—Seminoma probably originating from the epithelium of the testicular ducts.

Course—The patient was well and without any symptoms of his disease eight months after operation.

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ORCHIDOPEXY FOR VARICOCELE

A METHOD FOR TREATING VARICOCELE BY MEANS OF LIVING TISSUE

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FROM THE UROLOGICAL CLINIC OF SANTIAGO UNIVERSITY

VARICOCELE although a very common condition in men, is absolutely ignored by them in a large proportion of cases.

According to the various authors it consists in a varicose dilatation of the spermatic veins, although we have been able to demonstrate clinically that the dilatation affects both spermatic and epigastric veins, principally the latter group.

For a long time we had noticed by clinical examination of numerous patients that came under our consideration for the treatment of varicocele, that if we compressed under our finger the spermatic packet at the level of the external abdominal ring with patient in the recumbent position, on making him stand up without loosening our grasp of the veins, varicocele would be found in practically the same conditions as before the manoeuvre.

Dissection also showed us that the epigastric veins do not penetrate the inguinal canal but run externally and under cellular layers.

As varicocele is a condition practically always observed to the left, and remembering the course that the left spermatic vein follows until it reaches the renal vein, we suspected that there existed no independence between the spermatic and epigastric veins, as in case this independence were effective the reflux from the spermatic being impaired by our digital compression, replenishment of varicosed veins would be very slow and we would not find varicocele in the same conditions immediately after a patient had changed his position.

We then tried to find an anatomical confirmation to our clinical supposition in dissection. Carefully injecting the spermatic vein with fuchsin-gelatine and the epigastric with methyleneblue-gelatine, M. Pinto found that both systems of testicular veins anastomose freely, especially around the caudæ epididymi.

Furthermore, lately we have had occasion to examine patients with recurrent varicocele after having been submitted to operation by methods that act only upon the spermatic vein (abdominal ligature), and who had experienced no improvement in their symptoms.

With the method we propose, we act in a simple manner by means of orchidopexy with living tissues on both venous systems and on the relaxed scrotum. We call it the method of the double pulley and it consists in

First Part of Operation—A skin incision that starting from the outer third of the symphysis pubis ascends obliquely upwards for four or five inches following the bisection of the angle formed by the median line and

Poupart's ligament Cellular layers are cut through and edges of surgical wound separated by means of blunt separators. In the inferior part of the wound there appears the external abdominal ring and the venous packets penetrating under it, the shining aponeurosis of the external oblique occupies the superior part and the horizontal muscle fibres attached to the outer half of Poupart's ligament can be easily recognized.

From half to one inch above the arciform fibres of the external abdominal

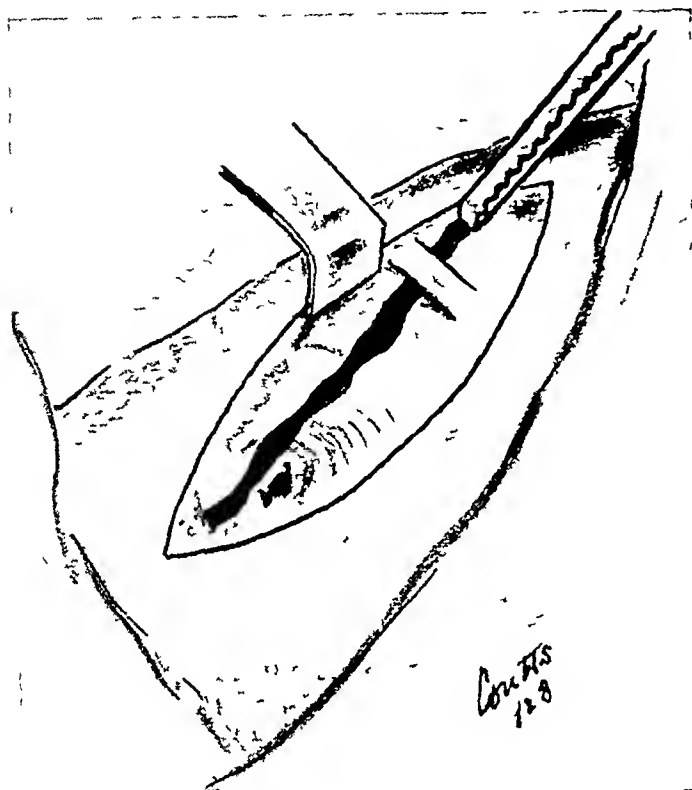


FIG 1.—Forming the aponeurotic bridge

ring we make with the bistouri two short parallel incisions in the external oblique muscle fascia and pass downwards and under them a Kocher's forceps, forming in this fashion an aponeurotic bridge (Del Valle)

We next divide longitudinally the different covers of the spermatic cord and select one of the most dilated veins of the anterior or spermatic packet. After isolating it by means of blunt dissection and softly pulling it outwards and downwards, we cut it as far up as possible between two catgut ligatures. Once we have done

this we pull, by means of the Kocher's forceps, the glandular end through and under the aponeurotic bridge (Fig 1)

Second Part of Operation—Between the fibrous layer that continues itself upwards with the fascia transversalis and the parietal layer of the tunica vaginalis, we slip a soft Pean forceps down into the bottom of the scrotum. Pushing the testicle upwards we try and catch with the forceps the small crescentic fold of the tunica vaginalis that passes downwards to the bottom of the sac. We easily recognise it if we have taken it between the forceps, because on pulling outwards the scrotum umbilicates. Holding the scrotum between our fingers we draw this portion of the tunica vaginalis softly outwards until it appears in the inferior part of the surgical wound. It can here be easily recognised owing to its smooth, brilliant serous appearance. With the bistouri we make a small incision through this portion of the tunica and pass a Kocher's forceps through the gap. By means of this forceps we grasp the vein that hangs over the aponeurotic bridge and drawing it downwards make it pass through this buttonhole.

ORCHIDOPEXY FOR VARICOCELE

Drawing the vein upwards we make it pass once more under the aponeurotic bridge. By drawing upwards or relaxing our hold on the vein we can leave the testicle at any height we desire. With a strong forceps we then crush under the aponeurotic bridge the different windings of the suspensory vein and passing a strong catgut suture under the block, finishing this part of the operation. We recommend a double ligature in order to insure complete success.

Under the aponeurotic bridge we place a catgut suture in order to join the fibres of the external muscle fascia. We close the surgical wound and place a suspensory bandage.

According to us, the first part of our operation, which resembles that of Del Valle only in the aponeurotic bridge made with the external oblique fascia, has an advantage over this method as it does not open the inguinal canal, a fact that surgically considered is of great importance.

We have so far operated over fifty patients, following our technique and the results so far obtained have been satisfactory. Some of our patients serving in the metropolitan police force, have been examined by us from six to ten months after operation and they were in perfect condition.

TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD MAY 14, 1928

The President, DR ASTLEY P C ASHHURST, in the Chair
CALVIN M SMYTH, JR, M D Recorder

BONE RESECTION TO EQUALIZE LENGTH OF LEGS

DR JAMES H BALDWIN presented a man, aged fifty-two, who was admitted to the Methodist Hospital, November 13, 1925, with the history that while at work, a wire cable on a hoisting machine became looped around his right leg, pulling him up into the air and causing a comminuted fracture of the tibia and fibula. As the result of a fracture of the left femur eight years before, that leg had been shortened an inch and a half. Under the fluoroscope, the fragments were manipulated into satisfactory position, a plaster case applied and in a week the patient was permitted to go home. Shortly after going home, due to improper use of the leg, the case was broken. On returning to the hospital, the fragments were found to be in worse position than at the time of fracture. Open reduction was elected. Bearing in mind that the left lower extremity was one and one-half inches shorter than the right, it was decided to try and remedy this. Three-quarters of an inch was cut from the end of each of the four fragments. These could then be placed in perfect alignment. The fibula was sutured with kangaroo tendon and the

tibia plated with a Sherman plate. Later the wound became infected and the plate was removed. There was a discharging sinus for several months but this finally healed. At present there is a fusion of the callus between the tibia and fibula. However there is no deformity, function is perfect, both extremities are the same length, there is no limp.

FIBROMA OF THE SHOULDER

DR JAMES H BALDWIN reported the case of a woman, age thirty-nine, who was admitted to the Methodist Hospital, July 26, 1927, with the following history. Three years before she had first noticed a small mass over

the left clavicle. She was then seen by the reporter, who at that time found a small freely movable painless mass about one inch in diameter. It was not

FIG 1.—Fungating fibroma of shoulder

DORRANCE AND McSHANE

It is very striking that 53 per cent of the total number of cases and 75 per cent of the number in which the duration could be determined from the history lived less than one and one-half years irrespective of the type of treatment they received

It would seem that the natural history of cancer of the tongue and floor of the mouth is one of short duration

A history of treatment prior to admission to the Philadelphia General Hospital was elicited from seventy-eight or 47.5 per cent of the patients

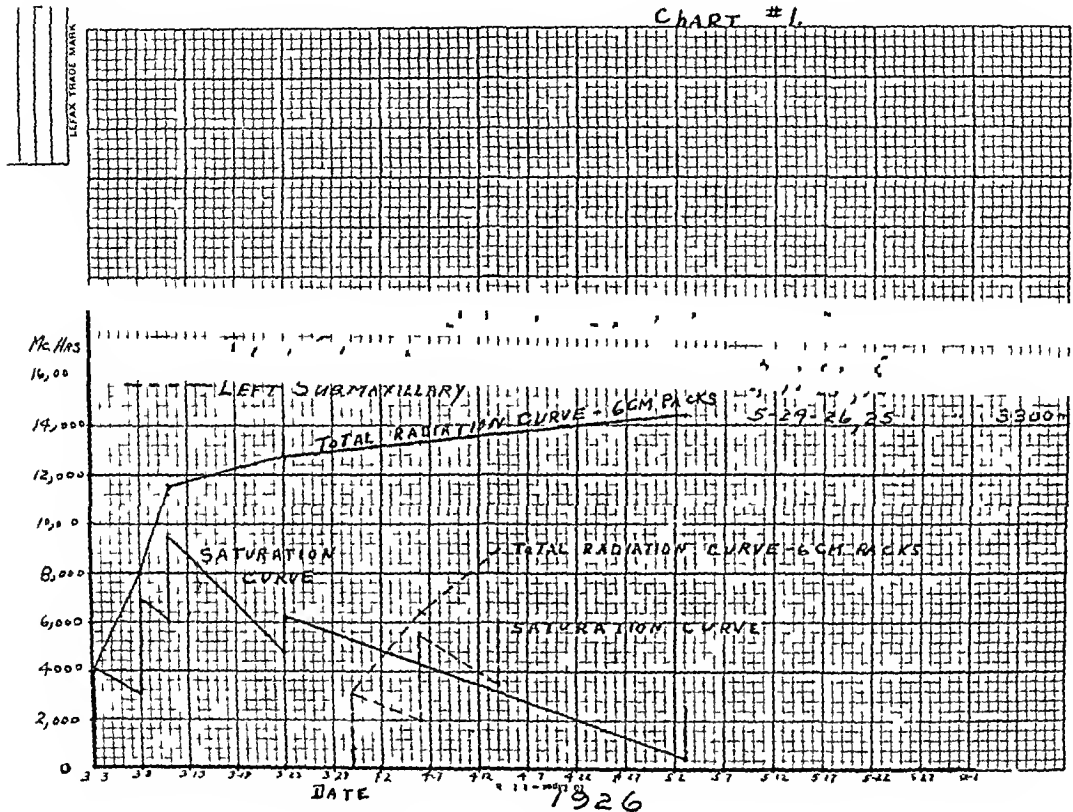


CHART 1—J. L. age sixty six years, admitted February 16 1926, died April 20, 1927. Lived one year and two months. Prickle cell carcinoma of the tongue. Figures in upper right hand corner show the treatment of local lesion with bare tubes. In the total radiation curve it will be seen that from March 3, 1926 to May 3, 1926, 14,400 millicurie hours of radiation was given to the right submaxillary region. During the period from March 30 to April 1, 8,500 millicurie hours were given to the left submaxillary region. The saturation curves show the amount of radiation in the tissue at any given time.

Practically every large hospital in Philadelphia and a few in neighboring cities are represented in this list

In our routine study of these cases, the Wassermann test was done in 112 cases. It was negative in seventy-four and positive in twenty-eight cases. The patients with concomitant syphilis ran a shorter course and their disease seemed more virulent than those with a negative Wassermann, when judged by the history of the duration of their disease.

The average length of life for this group from the onset of the cancer to their deaths was 14.5 months.

It has been our practice to disregard syphilis when treating malignancy of the mouth—to treat the latter and not the former. We have the impres-

PRIMARY EPITHELIOMA OF THE GASTRO-HEPATIC OMENTUM

tender, was single and was not adherent to the skin. Removal was advised but this was refused. The growth slowly increased in size and finally broke down, becoming a large foul smelling, sloughing mass, irregular in outline and from which there had been numerous more or less severe hæmorrhages. X-ray studies showed no metastases in the bones or mediastinum. There was no cervical or axillary involvement. The biopsy disclosed the mass to consist of fibrous tissue with no evidence of malignancy. At operation, August 14, 1927, the whole growth was found to be between the skin and the deep fascia and was easily shelled out in one mass. Repeated microscopic examinations failed to find any evidence of malignancy. The patient made an uneventful recovery and gained twenty-five pounds in weight.

PRIMARY EPITHELIOMA OF THE GASTRO-HEPATIC OMENTUM

DRS H. M. RIGHTER and HENRY K. SLELAUS, by invitation, reported the case of a colored woman, aged thirty-seven, who was admitted to the Philadelphia General Hospital, July 21, 1927, with an abdominal tumor.

In September, 1923, she was subjected to a complete supravaginal hysterectomy at another hospital, for a fibroid uterus, cystic ovaries and parovarian cyst on the left side. The history of the present trouble dates back seven years when the patient noticed a small lump in the left hypochondrium. It has gradually increased in size and consistency until it measured 12 x 8 x 6 cm. There had been a loss in weight of twenty pounds in the last nine months. For the past two years the woman has experienced episodes of severe abdominal pain associated with attacks of vomiting, since the mass in the abdomen has been increasing in size the attacks of pain have become more severe.

At operation, July 29, 1927 by Doctor Righter a large nodular tumor was exposed, which was thought to be between the two layers of the lesser omentum and apparently not connected with any viscus. The superficial leaflet of the gastro-hepatic omentum was incised and the mass rather easily extirpated. Because it was thought that the growth was malignant, 21 radium seeds of 45 millimilles strength were implanted in the bed of the tumor. The gall-bladder showed evidence of chronic nonspecific cholecystitis, but because of the patient's general condition, nothing further was done. Convalescence was rather stormy for about a week, but after that her strength gradually returned and she was discharged from the surgical ward six weeks after operation. The patient returned in September, 1927, for post-operative X-ray therapy. Eight months after the operation, the patient is in excellent health attending to her household duties.

Pathological Report (Dr. F. J. Jodzis, from the Philadelphia General Hospital). "The specimen is an irregular, ovoid, encapsulated tumor measuring 11 x 7.5 x 5 cm, soft and fluctuating in some areas and firm in others and having smaller spheroidal nodules on its surface. Sections through the firm areas are grayish-white, homogenous, elastic and resembling fibrous tissue. Section of the softer areas shows gradations from reddish-brown to grayish-yellow gelatinous areas of myxomatous degeneration. Microscopic sections show the tumor mass to be encapsulated with a thick layer of dense fibrous tissue. Beneath this there are small and large nests of ovoid cells with a fairly deeply-staining, eccentrically-placed nucleus. The cells are uniform in size, the majority of them being arranged in an acinar formation and in some of the acini these cells take on a cuboidal or low columnar shape. They do not appear malignant, but resemble in some degrees the parietal cells of the stomach, also vaguely, the cells of the pancreas. Some areas show these cells in groups of two and three giving the impression that there is an invasion of the fibrous tissue. No mitotic figures were seen in any of the areas. Diagnosis: Adenoma of unknown origin."

Professor James Ewing of Cornell to whom sections were submitted, had this to say "This is an epithelial alveolar tumor of very unusual structure. It is of glandular origin and malignant type. Its location suggests some relation to the pancreas and the structure is not inconsistent with that origin. It may arise from some aberrant island of gland tissue in this region where aberrant gland tissue is frequent."

Dr. B. L. Crawford, from the Jefferson Hospital, reported that sections from the tumor taken from different portions reveal slightly different pictures. In some areas there is extensive necrosis and in others there is considerable fibrous tissue with small clumps of cells scattered throughout, and in still others, the tumor is quite cellular, the tissue being composed of rather small, irregularly-shaped cells which are arranged to form indefinite acini and alveoli. The cells vary considerably in size and have large, deeply-staining nuclei. The cells forming the tumor are considered to be epithelial in origin and definitely glandular in type and while the cells somewhat resemble both liver and pancreatic tissue in places, it is thought that they probably more closely resemble the latter. However, there is nothing characteristic, such as epithelial-lined ducts or typical arrangement of the cells to identify the specific type of tissue. From the irregularity and variation in arrangement of the cells, the tumor is considered to be potentially malignant. Diagnosis: Epithelial tumor of aberrant gland tissue, probably undergoing malignant change."

A. Pearce Gould¹ at the beginning of the present century in his report of a "sarcomatous tumor of the gastro-hepatic omentum" was surprised that there were not more reports of primary tumors of the lesser omentum. At the present time, more than a quarter of a century later with the thousands upon thousands of laparotomies that have been performed, we can find the records of only two more.

Gould's patient was a man thirty-eight years of age who had a tumor removed from the lesser omentum. This tumor, weighed, when fresh, just over twenty-one pounds. The diagnosis, on microscopic section, was spindle-celled sarcoma. The patient made a good operative recovery and was free from recurrence more than four years later.

Murphy's² patient was a man of forty-nine who had a fibro-myo-myxoma telangiectatum which weighed thirty-four ounces. Clark³ reported a growth of the small omentum in a woman aged 60, but unfortunately no microscopic sections were made and there is no adequate description of the gross specimen.

In the previously reported instances of lesser omentum tumors there were found only connective tissue elements. The epithelial structures found in the growth reported in this paper very strongly favors, as suggested by Professor Ewing, an origin from an aberrant island of gland tissue, in all likelihood coming from either one of the primitive diverticula or evaginations which eventually become the adult liver and pancreas. Because the cells of this neoplasm bear a resemblance to the definitive pancreas, we incline to the view that it arose from one of the original ventral pancreatic diverticula, in spite of the fact that ducts were not found.

One of the striking things in connection with the symptomatology of these tumors is the tolerance that these patients show for the growing mass. Gould's patient had no severe local or general symptoms, except embarrass-

¹ Gould, A. Pearce. A Case of Sarcomatous Tumor of the Gastro-Hepatic Omentum. *Med. Chir. Gazette*, vol. LXXXIII, pp. 257-269, March, 1899-1900.

² Murphy, John B. Fibroma of the Gastro-Hepatic Omentum. *Surgery, Gynecology and Obstetrics*, vol. 1, pp. 315-319, October, 1905.

³ Clark, Jackson. Primary Tumor of the S. Omentum. *Trans. of the Path. Soc. of London*, vol. XLIII, p. 60, 1892.

PRIMARY EPITHELIOMA OF THE GASTRO-HEPATIC OMENTUM

ment of respiration and circulation from the mere bulk of the mass below the diaphragm. Murphy's patient had noticed the tumor nine years before and at no time were there any symptoms associated with it. In his own words, "If I could not feel it, I would not know I had it." Owen's patient, reported by Clark, had observed the growth for four years and her only complaint was pain due to the adhesions. The patient whose report is chronicled here is the only one who had any marked symptoms referable to the tumor.

In coming to a conclusion regarding the diagnosis, Gould considered retroperitoneal tumors, hydatid tumor, malignancy of the liver, splenic tumor or new growth of the kidney or adrenal. We would add to this list, malignancy of the stomach and pancreatic tumors. Pyelographic study and gastrointestinal X-ray would aid in excluding lesions of the stomach and kidneys. The long duration of the tumor with the absence of grave constitutional phenomena, such as vomiting, wasting, jaundice and ascites, would rule out malignancy of the liver. The more or less central position with the resonance to the left of the growth and the absence of constitutional symptoms, throws the diagnosis of tumor of the spleen into discard. The absence of fluctuation and the different outline are against hydatid tumor. The lateral mobility and the fact that it could not be separated from the liver would differentiate it from the retroperitoneal tumor. The long time the tumor was present, the absence of jaundice, digestive phenomena and the failure to lose weight, would invalidate the diagnosis of pancreatic tumor. The treatment is that which has been carried out in all of the reported instances, viz. Removal, and it might be worth while, as was done in this patient, to implant radium seeds into the bed of the tumor.

Dr. Richter remarked that it was in 1908 that Duane first suggested the burying of radium emanation directly in malignant growths, and that Janeway used the method which consisted of implanting glass "seeds", each containing one-half to one millicurie, within the tumor. The seeds were spaced about one centimetre apart. Some good results were obtained with this technic, but only too frequently it was followed by considerable necrosis and subsequent sloughing. While this result is undesirable in surface lesions, it is prone to be followed by fatal results in tumors within the peritoneal cavity. Hence, irradiation therapy of abdominal neoplasms had been confined largely to external radiation. Lately, however, a new procedure has been introduced which promises better clinical results. This improvement consists in the substitution of gold tubes for the bare

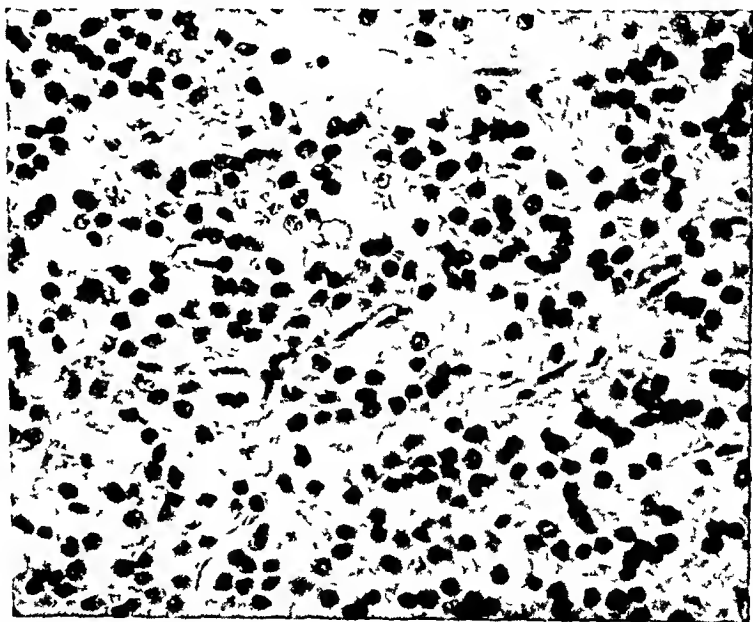


FIG. 1.—Photomicrograph of primary epithelioma of the gastro-hepatic omentum.

new procedure has been introduced which promises better clinical results.

This improvement consists in the substitution of gold tubes for the bare

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"seeds" By this means considerably larger doses can be concentrated within the limits of the tumor, and, on account of the greater screening effect of the gold, all but the most penetrating beta and gamma rays are removed, the tendency to necrosis and sloughing being very greatly reduced. From one to three millicuries may be used in these containers and the abdominal wound closed as soon as the implantation has been completed.

Levin in a paper published in the *J A M A* of January 28, 1928, reported four patients with carcinoma of the pylorus, one with carcinoma of the duodenum, one with carcinoma of the sigmoid and one with rectal carcinoma, all treated by the intra-neoplastic insertion of capillaries of radon plus the necessary palliative procedures, and, it is interesting to note that the insertion of the radon did not add to the hazard of the operation, and did cause a shrinkage of the tumor growth with a subsequent prolongation of life and comfort.

In the present case, twenty-one gold tubes, containing altogether 45 millicuries, were implanted in the bed of the tumor. This represents a dose of about six thousand millicurie hours. In addition a series of high voltage X-ray treatments were given at a later date. This latter treatment is now replaced, in some patients and in institutions having sufficient radium, by external irradiation with large radium packs containing from two to four grams of radium or its equivalent in emanation.

DR GEORGE M LAWS recalled a patient who had a tumor of the lower abdomen, which at operation was found to lie between the stomach and the transverse colon. The colon was pushed down in the pelvis and the omentum attached to the tumor. On enucleating, it was found to be quite friable and revealed cystic areas containing free fluid. The parietal peritoneum showed a great deal of irritation. This was a tumor of the gastro-colic omentum, separated from its attachments, enucleated and apparently no damage done to any important blood supply as the patient made a good recovery and was out of bed in two weeks. The pathological diagnosis of the tumor was fibrosarcoma.

BILATERAL ACOUSTIC NEUROFIBROMATA

DR THOMAS A SHALLOW reported the history of a woman, age twenty-four years, who was admitted to the Jefferson Hospital, in the service of Prof. Edward A. Strecker, December 30, 1927, complaining of headache. Loss of hearing in both ears, associated with head noises. Loss of vision in left eye, almost complete loss of vision in the right eye. Inability to walk. In her family history there was no history of malignancy, tuberculosis, diabetes, nervous or mental diseases.

Six years ago, one year after the birth of a child, she frequently experienced dull pain in the neck, associated with attacks of vertigo. These symptoms were aggravated when she stooped and recurred at intervals for four years. In 1926, it was noticed that she had bulging of both eyes, more marked in the left eye. Associated with the bulging there was some loss of vision in both eyes. Since March, 1926, the vision has become progressively worse. About this time her family noticed that she had difficulty in hearing, and she complained of hearing bells in her head and also complained of a buzzing noise. These symptoms persisted until December of 1926, when

BILATERAL ACOUSTIC NEUROFIBROMATA

there was some temporary improvement in her hearing, but since that time her hearing has become progressively worse. She did not complain of any headache until the latter part of 1926. Then she had attacks of severe frontal headache and vomiting. These spells would come on about once a month and would last from several hours to two days. Six months after the onset, these attacks abated and only recurred occasionally. At no time had she projectile vomiting.

Physical Examination

—Vision Right eye 22/100 Left eye no vision

Pupils 7 mm, react sluggishly to light, lateral nystagmus Ophthalmic Ex-

amination—O D, media clear, disk very pale throughout, margins blurred, cup is obscured, veins tortuous throughout, arteries are contracted but fairly straight O S,

media clear, disk intensely pale, disk is obscured, margins blurred. These conditions indicated optic atrophy bilateral, secondary to choked disk. There is very slight evidence of exophthalmos.

Head—In the supra-

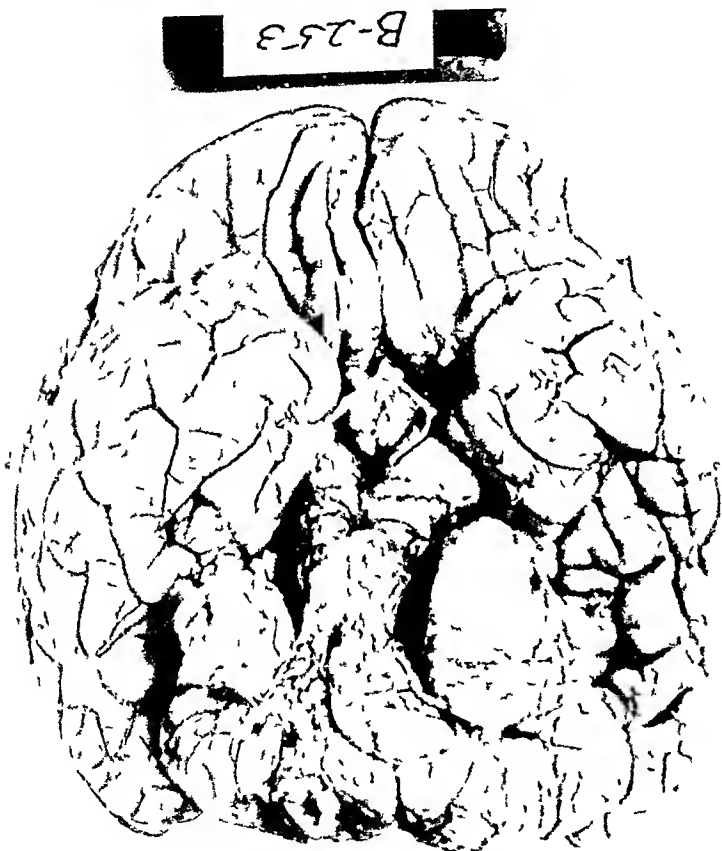
orbital region there were several small nodules the size of millet seeds. There were similar nodules on the scalp immediately above the hair line. There was a diminution of sensation in the left side of the face. Nose and Throat examination was negative except for pharyngitis. There was a slight enlargement of the thyroid gland. On the anterior surface of the chest there was a scar where a tumor had been removed one month before admission to the hospital. The nature of this tumor was not known. Heart and lungs did not show any evidence of pathology. There were no gastro-intestinal findings of importance. Menstruation was established at the age of twelve and had always been regular.

Extremities Upper—On the outer side of the index finger of the right hand were several nodules similar to those in the supraorbital region and on the scalp.

Neurological Examination—Upper extremities

Superficial and deep reflexes present and normal. Grip and resistance good, no tremor present. No alteration in sensation of either hand. She is able to determine objects placed in her hands but there is slight delay in the right hand. Lower extremities No ankle clonus or Babinski reaction present. Knee jerks present and normal. She swayed to the left when she attempted to walk,

Fig. 1—Showing multiple tumors arising from acoustic nerve of each side



and was unable to stand on either foot unassisted Diminished sensation of the right leg on the outer half from the knee to the ankle Slight rigidity of the right leg The Barany Test suggested a lesion centrally located, involving the pons, more on the left side There also appeared to be some involvement of the vermis, possibly from pressure Fork Test—Right ear, slight bone conduction, no air conduction Left ear, slight bone conduction, no air

conduction Weber's Test—Does not hear fork when placed on the vertex of the skull Rinne's Test—Negative in both ears Inflammatory disease of the ear was not found and there was no evidence that it had existed in the past

X-ray Report of Dr Leon Solis-Cohen—“Study of stereoscopic image of the right side of the skull leads us to conclude that there is definite increase in intracranial tension as the stereoscopic films bring forth the greater prominence of the convolution markings of the skull From these views also the sella turcica, while within normal limits, might still be con-

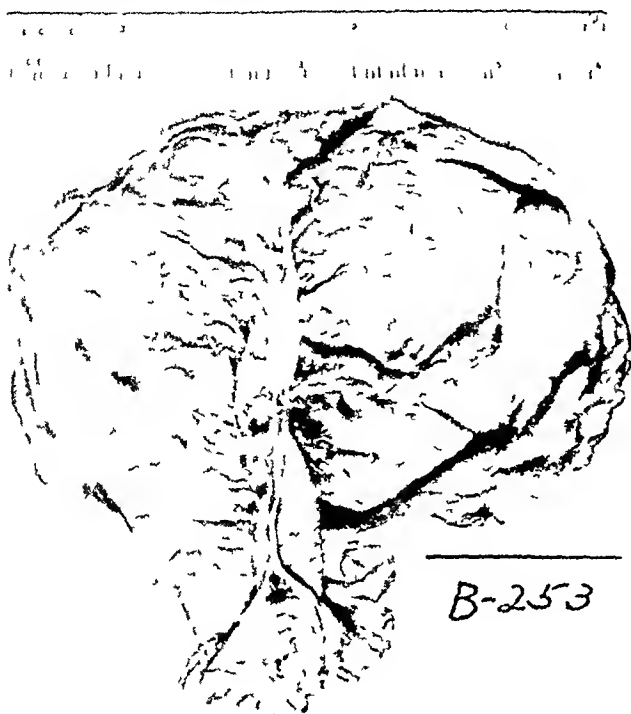


FIG 2—Showing the multiple tumors of the dura

sidered deep There is definite calcification in the mid-parietal region, presumably near the ventricles, presenting an irregular ear-shaped appearance, about one inch and a half by half an inch, that suggests the presence of calcification The convolution markings are more prominent on the right side than on the left ”

The diagnosis made in Professor Strecker's clinic was BRAIN TUMOR involving the eighth nerve

Doctor DaCosta presented this case to his clinic on January 25, 1928 He stated, because of the bilateral absence of hearing he strongly suspected a multiple lesion, that is a lesion of both acoustic nerves instead of a single eighth nerve tumor He diagnosed this case as a bilateral acoustic tumor and multiple neuro-fibromatosis Doctor Shallow removed a small tumor from the scalp for examination The laboratory examination showed that it was a neuro-fibroma

A cerebellar decompression was done by the reporter on February 4, 1928, with the hope of saving the moderate vision which still remained The patient died suddenly forty-eight hours after the operation

Autopsy—In the scalp and in the subcutaneous tissue over the trunk a number of small, firm, circumscribed nodules can be felt These do not appear to have any distribution that follow in the course of the main nerves

The dura is thickened and adherent to the piaarachnoid On the inner surface of the dura there are innumerable small circumscribed, slightly elevated, firm gray nodules which protrude from the inner surface These

BILATERAL ACOUSTIC NEUROFIBROMA

nodules vary in size from a pin head to the largest measuring $1\frac{1}{2}$ cm in its greatest dimensions. Several of these large nodules form definite depressions in the brain substance but are not adherent to the piaarachnoid. No nodules are observed in the piaarachnoid over the cortex of the brain.

The brain weighed 1360 Gms, a number of definite nodules were observed at its base, two of the largest of these are in the cerebello-pontile angle, one on each side. Each one of these causes a depression, both on the pons anteriorly and on each lobe of the cerebellum posteriorly. The left tumor mass measures $4\frac{1}{2} \times 3\frac{1}{2} \times 3\frac{1}{4}$ cm. The right tumor mass measures $3 \times 2\frac{1}{2} \times 2$ cm. These tumors are quite similar. Both are adherent to the meninges and originated in the eighth nerve trunks. On the third cranial nerve



FIG 3—Microphotograph of the section of the tumor removed from the eighth nerve.

on the left side there is a small tumor mass about 3 mm in diameter, definitely adherent to the trunk. In the Gasserian ganglion of the right side

there is a small tumor. The right and left of the seventh nerve both show a small tumor nodule attached to the nerve trunk. The right eighth nerve is included in a large tumor which extends into the internal auditory canal. The right ninth, tenth and eleventh nerves are included in the tumor mass, which extends into the right jugular foramen. There is slight destruction of the surrounding bone. All the ventricles are markedly distended with clear fluid. The specimen was preserved intact.



FIG 4—Microphotograph of the subcutaneous nodule removed before operation.

of the brain are similar in histological structure. They are composed of rather cellular tissue, the fibres of which show definite whorls. In some

Histological Examination—The tumor nodules in the dura and the base

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areas the tissue is composed largely of spindle whorls while in other areas nerve fibres predominate. In some areas of the tumor spindle cells predominate. Some of the smaller nodules seem to arise from the nerve trunks in the meninges.

Anatomical Diagnosis—Neuro-fibromatosis involving the subcutaneous tissues, the dura and the cranial nerves.

Histological Diagnosis—Neuro-fibromatosis of the meninges and cranial nerves. Histologically the cranial tumors are similar in structure to the subcutaneous nodules which were removed before the cranial operation.

DR FRANCIS C. GRANT said that he had seen three cases of von Recklinghausen's disease in the Frazier service at the University Hospital, one of which had bilateral tumors of the eighth nerve but no other cranial nerve involvement. The literature shows definitely that the eighth is the most common intracranial nerve involved in this condition. There appears to be no explanation for it. The second case had eighth nerve involvement, and operation was followed by recurrence on the opposite side two and one-half years later. Neither case had any peripheral manifestations of von Recklinghausen's disease. The third case did however and it came to necropsy which showed a condition similar to Doctor Shallow's case, only not so extensive. It showed single tumor of the acoustic nerve, entirely unsuspected, and von Recklinghausen's disease of the periphery. The operative difficulties in this case must have been extremely great as far as exposure of the growth was concerned. Even if the acoustic tumor could have been removed the others would have developed and the outcome would have been the same.

MUSCULO-SPIRAL INJURY COMPLICATING FRACTURE OF HUMERUS

DR BERNARD H. NEUBAUER presented a man, age twenty-six, who September 16, 1926, sustained an injury to the left arm. There was marked deformity of the upper arm and a paralysis of the muscles of extension in the arm, forearm and wrist. X-ray showed a spiral fracture of the humerus through the musculo-spiral groove with displacement of the fractured fragments. September 17, 1926, an unsuccessful attempt at closed reduction was made. The wrist and hand were placed in a cock-up splint. October 5, 1926, open reduction was done, both ends of fractured fragments were isolated. The musculo-spiral nerve was lying directly in this path. The sheath of the nerve and several of the nerve bundles had been cut by the sharp point of the fragments. The nerve was isolated, the sharp pointed ends of the bones were removed and the fragments placed in apposition and secured with two wire nails. The soft fibrous tissue that had formed in the open area of the nerve sheath and nerve bundles was excised, and the nerve united by two catgut stitches placed in the sheath. The patient was placed in a plaster body and arm case with the wrist and hand held in extended position. The fracture united satisfactorily, the nails being removed thirty days after operation. Four months after the injury, the musculo-spiral nerve showed beginning return to function. This function has gradually improved to the present day now approximating 90 per cent normal.

CRANIOPLASTY FOR CLOSURE OF DEFECT

DR BERNARD B. NEUBAUER presented a man, age fifty-four, who was injured May 19, 1926. While he was using a wrench to drop the hopper on

CRANIOPLASTY FOR CLOSURE OF DEFECT

a coal car, the wrench slipped, whirling around and striking the patient on the right side of his head. He was knocked unconscious and taken to a hospital. There he remained four and one-half weeks—following an operation for decompression.

Five weeks after the accident when first seen by the reporter he complained of a feeling of emptiness in the open side of his head. He had headache, dizziness and nausea but did not vomit. Coughing caused the same sensations as the bending forward and both, seemed to the patient, to push the brain further out from the head.

Riding in street cars, especially when crossing car tracks, caused pain and discomfort. At times he complained of throbbing in the head. Lying in bed, with his head at a low level, gave him the feeling that his brain was pushing out, and he had an associated nausea. The patient was afraid that wearing his hat would injure his brain because his head felt so large when his hat was worn.

The physical examination showed a large defect in the calvarium of the right fronto-parietal area, 8 cm in length and 6.5 cm in width, of oval shape. The brain tissue was protruding and showed pulsation. There was no facial paralysis and there was no paralysis of the extremities on either side. The eye grounds and color fields were normal. The reflexes were equal on both sides.

The day following his first examination, the spinal pressure reading was 26 mm of mercury. During the following six weeks the patient was given one 45 cc intravenous injection of 15 per cent hypertonic saline each week, and one dram of magnesium sulphate was given before breakfast each day. By August 24, the hernia cerebri had receded to within the normal limit. The spinal pressure reading was 12 mm of mercury.

August 26, a piece of cardboard was placed over the open space in the skull and adhesive used to hold it in place. A head bandage was applied. This procedure was adopted to ascertain what symptoms, if any, might develop from closing the defect. The patient reported that he felt better with the opening covered—and after a six weeks trial, it was decided to make a permanent closure.

October 12, Cranioplasty was undertaken. A large horseshoe incision was made, to include, both the defect and the area from which a graft was to be removed. Considerable difficulty was experienced in separating the scalp from the underlying dura, especially at the several points where the brain tissue had protruded through the dura. All openings in the dura were sutured. The eburnated bone formed about the opening was removed. A pattern of gauze, of the required dimension, was placed upon the exposed area from which the graft was to be cut. When about one-third of the graft had been chiseled free, the anaesthetist was advised that patient's condition had been gradually becoming worse and that pulse was about 140. The operation was discontinued and the flap sutured. The patient was returned to bed and treated for shock.

November 23, the second stage of the operation was undertaken. This time a horseshoe flap incision was made over the defect only. The scalp was very easily separated from the underlying dura which was found entirely closed. The edges of the bone were curetted.

Having decided to use a transplant from the tibia an osteo-periosteal graft was removed from its internal surface. The graft was in three parts, each 10 cm long by 2.5 cm wide. The three strips were placed with their lengthwise edges together and the ends resting upon the edge of the defect. The excess graft was removed to conform with the contour of the opening.

PHILADELPHIA ACADEMY OF SURGERY

The periosteum was sutured to periosteum both in the graft area and to the periosteum covering the skull. The skin flap was closed without drainage.

Two and one-half weeks later, the graft area felt solid to the touch. The subsequent X-rays show a gradual increase in density of the grafted area to the present point of solidification.

DR J S RODMAN said that the König-Mueller technic of using the outer table of the skull in the closure of cranial defects has always resulted in more or less severe shock in his experience. One patient, a child, died of shock. The use of a graft from the tibia as done by Doctor Neubauer in this case, seems much less likely to result in shock in that the necessary hammering and chiseling that goes on in order to raise such a flap from the skull is obviated. It is this repeated trauma to the head which results in the severe shock which it is so usual to see when the flap is taken from the outer table of the skull. An additional advantage is that time is saved because the assistant can raise the flap at the same time that the defect in the skull is being prepared to receive it.

CANCER OF THE TONGUE AND FLOOR OF THE MOUTH

DR GEORGE M DORRANCE and DR JAMES K McSHANE (by invitation) read a paper with the above title for which see page 1007. To illustrate their paper, the essayists presented three patients, as follows:

CASE I—A man, age sixty-seven, was admitted to the Philadelphia General Hospital, September 16, 1926, with a growth involving the left floor of the mouth. There was no demonstrable adenopathy in the neck at that time. Biopsy resulted in the diagnosis of prickle-cell cancer. He received four series of neck radiations, the local condition was treated at first with bare tubes and later with gold tubes. He is in good health today and free from all evidence of cancer.

CASE II—A man, age seventy-four, was admitted to the Philadelphia General Hospital, January 21, 1926, with a lesion involving the under surface of the tongue and floor of the mouth. Biopsy showed prickle-cell cancer. There were four palpable glands in the right side of the neck beneath the sternomastoid muscle. The neck was treated by radium packs and the local lesion by 25 bare tubes in the tongue area for a total of 1830 mc hours. Two years and four months after his first treatment he is free from all evidence of cancer.

CASE III—A man, age seventy-three, was first seen by Doctor Dorrance June 25, 1923, at which time he had a squamous-cell carcinoma, which extensively involved the floor of the mouth, frenum of the tongue and mucosa of the lower jaw. His treatment which was commenced in June, 1923, and continued until June, 1926, consisted in all, of sixteen of bare tubes in the lesion. For all he had 61503 mc hours radiation. At present he is free from all evidence of cancer.

The charts showing the total radiation and saturation curves for the above patients are included in the body of the paper.

DR DAMON B PFEIFFER asked whether Doctor Dorrance had given up bloc dissection of the neck in metastatic involvement. Not one of these cases was cured by radium, might they not have been helped by bloc dissection?

DR A P C ASHHURST said that some years ago Doctor Bloodgood pointed out that the only patients with cancer of the tongue or floor of the mouth whom he had been able to cure had been those whose disease was so far

PRIMARY EXTRARENAL HYPERNEPHROMA

advanced when first seen that it was necessary to dissect the neck the floor of the mouth, and the glands in one piece. In later years Doctor Bloodgood has announced that no case with metastases in the neck is worth operating on at all, since they all die. Doctor Ashhurst desired to ask Doctor Dorrance which view he thinks to be correct. Doctor Ashhurst also desired to know, when Doctor Dorrance speaks of ligation of the external carotid, whether he means merely ligation or whether he really means excision, in Dawbarn's sense. Doctor Ashhurst had found mere ligation of little effect in checking the blood supply because the collateral circulation is very free. However, if one doubly ligates the external carotid at the bifurcation and then doubly ligates the superior thyroid, the lingual, facial, posterior auricular, occipital, internal maxillary, and temporal arteries, and excises the trunk of the external carotid thus set free from all its branches, very little collateral circulation can develop, and if this operation is done on both sides of the neck simultaneously, or at intervals of a few days only, then the malignant growth is really starved, edema will subside, and the patient will be temporarily relieved. If the growth invades the upper part of the neck it may be impossible, of course, to expose the external carotid as high up as its division into internal maxillary and temporal arteries. Under such circumstances Doctor Ashhurst had excised the lower part of the external carotid and ligated the main trunk as high as possible, and then doubly ligated and divided the temporal artery above the zygoma. He had observed in a few of his earlier cases, that where simple ligation of the external carotid had been done on one side of the neck, only, pulsation returned across the scalp by way of the temporals in a couple of days.

DR GEORGE M. DORRANCE said that as the collateral circulation is so rapidly established after ligation, he now excises a portion of the artery. In cases with involvement of the glands of the neck, the speaker has never effected a cure by radiation or excision. Bloc dissection carries such a high operative mortality that it is rarely justified, in view of the unsatisfactory results. Regarding the results with radium, the speaker added that some cases are radium sensitive, some give good results in treatment and some do not. He believes that he gets better results from the introduction of radium than from surgery, the primary mortality is less and the time in the hospital is less. The best results were in cases where a positive biopsy was not obtained. It is remarkable the number of patients that are sent to the clinic with the diagnosis of cancer in whom biopsy reveals a benign lesion.

PRIMARY EXTRARENAL HYPERNEPHROMA

DR ALBERT E. BOTHE, by invitation, read a paper with the above title, for which see page 1028

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD MAY 9, 1928

The President, DR FRANK S MATHEWS, in the Chair

SLIPPING PATELLA

DR GUILFORD S DUDLEY presented a woman, twenty-five years old, whose complaint had been dislocations of both patellæ. Such accidents always occurred either as the result of a slight miscalculation while walking or while descending stairs, resulting in a fall to the ground. She had always been able to manipulate the bone back into position and to resume walking immediately. The involved knee, usually the left, then felt weak for a few days but never became swollen. Past history stated that she had been dragged along the ground by both feet when about seven years of age, but was negative for anterior poliomyelitis or other serious illness. Her sister also showed unusual mobility of both patellæ, but had never had any dislocation.

Examination showed marked lateral mobility of both patellæ and the ability of the patient, by contraction of the quadriceps, to voluntarily dislocate the left patella laterally. This seemed to be due, at least in part, to the pull of the lateral portion of the quadriceps (*vastus externus*), since inspection and palpation of the thighs showed a distinct lack of rounded contour on the antero-medial (*vastus internus*) aspect of the left thigh, and comparatively little pull by this portion of the muscle. The circumference of this thigh was more than one inch less than that of its neighbor, but both calves showed equal measurements.

At operation, October 31, 1927, the procedure described by Soutter was carried out. A tunnel was drilled through the patella and through the inner tuberosity of the tibia at an angle of forty-five degrees, with the transverse plane of the knee-joint and a strip of fascia lata passed through these tunnels to anchor the patella in place. In addition, the marked laxity of the capsular structures on the inner aspect of the joint was improved by a continuous suture of chromic catgut. Since operation there has been no recurrence of the patellar dislocation and the stability of the knee-joint has been greatly improved.

GASTRO-JEJUNAL ULCER

DR GUILFORD S DUDLEY presented a man who, when first admitted to the Second Surgical Division of Bellevue Hospital in June, 1923, was fifty-six years of age. At that time he gave a history of recurring attacks of upper abdominal pain with loss of weight. Examination showed distinct tenderness in the right upper abdominal quadrant but no other abnormality. Radiographic examination was negative for duodenal ulcer but did show a deformity suggestive of periduodenal adhesions consequent to gall-bladder disease. At operation there was found a duodenal ulcer adherent to the under surface of the liver. Upon division of this adhesion there took place a minute perforation of the ulcer, which was closed by purse-string sutures. A posterior gastro-enterostomy was then performed.

PSEUDO-CYST OF THE PANCREAS

He was well until the latter part of 1925 when he was injured in an automobile accident, and dated the recurrence of symptoms from that time. Radiographic and fluoroscopic examination showed a well-functioning gastro-enterostomy stoma but no other abnormality. Despite this his symptoms persisted and he continued to lose weight. By October, 1927 he had lost forty pounds with a corresponding diminution in strength. Repetition of gastro-intestinal fluoroscopy and X-ray films was again negative. Early in 1928 he suffered an acute profuse gastric hæmorrhage and was taken by ambulance to another hospital where still another X-ray examination was found to be negative. Following rest and dietetic treatment he gained twenty pounds' weight and was readmitted to Bellevue Hospital ten weeks later for observation.

After careful fluoroscopy the roentgenologist was willing to report that a persistent fleck was visible in the region of the stoma and that this finding was suggestive of the presence of a gastro-jejunal ulcer. The X-ray film, however, did not show any lesion.

The interesting feature of this case rests in the many negative X-ray reports and the somewhat doubtful nature of the diagnosis at present. If the source of his recent and only gastric hæmorrhage in five years was a gastro-jejunal ulcer, what are the probabilities of its repetition? Should his age and his improvement following dietetic influence one's judgment with regard to operative treatment?

DR JOHN A. MCCREERY said that he had under observation a patient with an almost similar history. The man had complete absence of symptoms until one month ago, since which time there has been marked loss in weight and two or three extensive hæmorrhages but almost no pain. Doctor McCreery's impression is that he has a marginal ulcer and, because of the extensive hæmorrhages, he plans an exploratory operation. Doctor MacGuire reported a case a year or so ago of marginal ulcer with such serious hæmorrhages that it was considered perilous to touch him but finally operation was performed to save life and resulted satisfactorily.

DR SETH M. MILLIKEN said that he had a patient who in 1910 underwent a gastro-enterostomy for duodenal ulcer. He was admitted to Bellevue Hospital in March, 1913, for a very severe hæmorrhage without apparent cause. The patient was in such bad condition that no operation was done, but he was kept under observation and medical treatment was carried on for four weeks. He improved and refused exploration. He was seen at intervals after that for ten years, during which time he had had only one small hæmorrhage three years after leaving the hospital.

PSEUDO-CYST OF THE PANCREAS

DR GUILFORD S. DUDLEY presented a man, thirty-five years of age, shown through the courtesy of Doctor Hartwell. He was injured in an automobile accident in February, 1926. The region of his left upper abdomen was struck by the ball of the gear-shift lever. Ecchymosis and local tenderness persisted for about one week but he had no further symptoms until November, 1927.

Since that time four attacks of severe upper abdominal pain have occurred. Obstinate constipation and persistent vomiting accompanied every attack, suggesting the possibility of an intestinal lesion. A gastro-intestinal series of X-rays proved to be negative. Accompanying the first attack jaundice

appeared and persisted for about two weeks, but did not occur with any of the subsequent attacks. Following the fourth attack (February 1, 1928) the patient noted an upper abdominal mass for the first time. Throughout the period of illness there was a loss of about fifteen pounds' weight but no other noteworthy symptoms.

Examination showed a visible mass in the left upper abdominal quadrant extending from the midline outward for two to three inches. Palpation and percussion gave the impression that the mass was globular and cystic and led to the pre-operative diagnosis of pancreatic cyst.

At operation, February 17, 1928, there was found presenting through the gastro-hepatic omentum a thin-walled irregularly spherical cyst containing about one pint of clear, slightly brownish-colored fluid. The lining membrane was smooth everywhere without any suggestion of new growth. Because of the impracticability of removal, the cyst was evacuated by aspiration, marsupialized, and a fragment of its wall excised for histological examination. The fluid was alkaline and contained trypsin. The cyst wall was lined by smooth fibrous tissue thrown into papillary folds with no evidence of malignant change.

Following operation, cicatrization rapidly transformed the cyst cavity into a fistulous tract. From this a thin, skin-digesting fluid drained continuously for six weeks, since which time the tract has closed three times and reopened twice. It has now remained closed for three weeks. No dietary restrictions have been imposed and the only effort employed locally to hasten healing was an instillation of six-per-cent silver nitrate into the fistula. Since the cessation of drainage the patient has had two or three twinges of upper abdominal pain following exercise but no other symptoms. He has regained his weight and general feeling of well-being.

He is presented to the society because of the interesting association in his history of the two usual causes of pseudo-cyst formation. Probably, however, the lapse of twenty-one months from the time of injury to the onset of symptoms would rule out trauma as the etiological factor and lead to the assumption that his four attacks of upper abdominal pain were, in reality, attacks of acute pancreatitis which resulted in cyst formation.

DR NATHAN W. GREEN said that with the history of injury one might naturally think the condition had its inception then, but the interval of twenty-one months before the appearance of the symptoms would incline one to doubt this. The speaker did not see why, however, it would not be possible for a hæmorrhage to have occurred during the injury, and a small amount of pancreatic juice set free to digest the extravasated blood and to form a cyst which showed its presence only twenty-one months later. The speaker had had a case, though with no history of injury, but with the same pathology. On operating there was found a pseudo-cyst of the pancreas which seemed to be subsiding after an inflammatory condition.

ENDOTHELIOMA OF THE PERITONEUM

DR GUILFORD S. DUDLEY presented a woman who when first admitted to the Second Surgical Division of Bellevue Hospital in May, 1922, was twenty-one years old. She complained of a right inguinal hernia. At that time she gave the history of having had pleurisy in 1918, and of having been diagnosed as suffering from tuberculous peritonitis in 1921, because of the

ENDOTHELIOMA OF THE PERITONEUM

presence of free fluid within the abdomen. Although examination revealed no evidence of tuberculosis her hernia was repaired under local anæsthesia.

She was readmitted to the hospital in July, 1922, complaining of indefinite lower abdominal pain and abdominal distention. The pre-operative diagnosis was tuberculous peritonitis. The peritoneal cavity contained about 3000 cc of clear fluid and in its pelvic portion was a collection of light red, coagulated, jelly-like material. The visceral and parietal peritoneum wherever seen was studded with milium masses. The uterus, tubes and ovaries seemed to be less involved than adjacent structures and could be excluded as the primary focus. The appendix appeared to show greater involvement than any other structure. It was removed and the abdomen closed without drainage. Histologically the serosa of the appendix showed thickening by a growth of cells resembling endothelial cells and the pathological diagnosis was given as pseudo-myxoma peritonei.

By October, 1922, her abdomen had again become distended with fluid. Laparotomy evacuated about a gallon of thick, yellowish, sour-odored fluid. All visible coils of intestine were matted together by a heavy fibrinous exudate which also tended to form a diaphragm separating the pelvic from the general peritoneal cavity. A piece of the greatly thickened parietal peritoneum was excised, a culture was taken and the abdominal wall closed with drainage to the right lower abdomen. Pathological diagnosis was subacute productive peritonitis and the culture showed a non-hemolytic streptococcus. Drainage persisted for six weeks.

In October, 1923, February, 1924, and October, 1924, she received X-ray therapy to the abdomen. Menstruation stopped after beginning of this treatment and in January, 1925, her abdomen was opened for the third time because of pain and reaccumulation of fluid. Fully a gallon of soapy, opalescent fluid was evacuated. The left tube and ovary were matted together in a cystic mass and were removed. Microscopic examination showed the general structure of an adenocarcinoma of the peritoneum. Review of the slides from the appendix showed precisely the same type of growth and the former diagnosis of pseudo-myxoma was withdrawn. The origin of the adenocarcinoma could not be determined.

In May, 1925, X-ray therapy was again administered and in June, 1925, two gallons of clear amber-colored fluid was evacuated from her peritoneal cavity by laparotomy. The intestines were remarkably free from adhesions. All omental fat was absent, and all that remained of omentum were its blood-vessels. The lowermost margin of these vessels was held together by a mass of tumor tissue, thus creating the impression of a rope portiere.

Her fifth laparotomy was performed in November, 1926, at which time two gallons of amber-colored fluid were again evacuated. Many nodules were palpable in the mesentery of the small intestine and the surface of the liver was of a granular peppery feel. The serosa of the intestines and the parietal peritoneum appeared congested but did not show the milium nodules formerly observed. One small pedunculated nodule was removed from the surface of a loop of small intestine.

Examination of this specimen showed, in places, the same gland-like arrangement noted in former specimens but for, by far the greater part, the tumor cells were diffusely arranged so that the impression gained was that of an hypernephroma. However, a diagnosis of hypernephroma was not justified in Doctor Symmer's opinion because of the notorious fact that metastasizing tumors not infrequently change in their morphology. In his review of all the sections from this case, he was inclined to the impression

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that it represented a so-called mesothelial carcinoma or endothelioma arising in the peritoneum itself

Between November, 1926, and the time of her sixth laparotomy in June, 1927, the patient had four more X-ray treatments. At this operation six quarts of greenish-yellow fluid were evacuated. Since then there has been no reaccumulation of fluid and the patient has been in good general health. Since January, 1924, she has taken ovarian extract from time to time for the control of symptoms due to her artificial menopause.

POLYPOID ADENOCARCINOMA OF THE JEJUNUM WITH ACUTE INTUSSUSCEPTION

DR NATHAN W. GREEN presented a woman, age thirty-four, who was admitted to Surgical Division A, St. Luke's Hospital, June 25, 1927. Her chief complaint on admission was nausea and vomiting for two days previous to admission. Present illness started twenty-five days previous to admission, when she returned from an outing with a heavy cold which lasted for some days. She then was taken with severe cramps in her abdomen. Previous to this she had been on a special diet for a "nervous stomach" for two years. She had become a shadow. Two days before admission, after a gastro-intestinal roentgenogram she was taken with constant nausea and vomiting, until in collapse she was rushed to the hospital. She stated that abdominal cramps were constant and indescribable. Her gastro-intestinal history showed her to have had a fair appetite and to have been constipated since coming to America in 1920. A fruit diet corrected this somewhat.

On examination she presented the appearance of a poorly developed woman who appeared acutely ill. Abdominal examination showed the following: Scaphoid in appearance with a mass about the size of a potato, which could be palpated in the midline just above the symphysis. There was moderate tenderness in this area as also in the right lower quadrant where there was some spasm. Pelvic examination revealed the uterus enlarged and on its posterior wall a hard firm small mass. Rectal examination was negative. The pre-operative impression was fibroid of the uterus, partial acute intestinal obstruction. Upon opening the abdomen, starting about four feet from the ligament of Treitz, there was an intussuscepted mass about sixteen inches long, the outer loop being 6 cm. in diameter. The outside loop of the intestine was red, but no evidence in the intussuscepted loops of gangrene. After the reduction of the intussusception a movable mass about the size of a bantam's egg was felt within the intestine, apparently on a pedicle which could be pulled up and down for a distance of about 4 cm. either way. The intussusception, which appeared to be inverted three times, was reduced and the polypoid mass felt. About five inches of gut with the mass was resected. The ends of the sectioned gut were tied with chromic gut and inverted. The anastomosis was then made by the side-to-side method, the new stoma being 3 to 5 cm. long. Chromic continuous suture was made going halfway around each way for the first suture and this was reinforced by interrupted silk.

The post-operative convalescence was somewhat complicated. The patient was very ill for about a week and on the eighth day the wound began to discharge yellow pus. She was, however, allowed up on the twentieth day and was discharged improved on the thirty-first day post-operationem. Her maximum temperature was $102\frac{1}{5}$, rectal, on the second day after operation and her maximum pulse rate was 132 per minute on the same day. The pathological report from the laboratory was "polypoid adenocarcinoma of

LEIOMYOMA OF THE JEJUNUM WITH INTUSSUSCEPTION

the jejunum" "The tumor has all the morphology of malignancy, being an adenocarcinoma, though still polypoid and not excavated "

LEIOMYOMA OF THE JEJUNUM WITH INTUSSUSCEPTION

DR NATHAN W GREEN presented a man, age about sixty-seven, who was admitted to the medical service of Doctor Fissell June 17, 1927 His chief complaint was abdominal pain for six months About two years previous



FIG 1—May 24, 1927 Before operation showing prepyloric filling defect

to admission he began having frequency and urgency of urination and had some genito-urinary treatment About six months previous to admission he began having intermittent attacks of belching, chiefly directly after meals This improved somewhat after several months but still remained About the same time he began having pain in his abdomen This usually appeared in the epigastrium, but not infrequently it lay on the left side at the level of the umbilicus The pain was dull and each attack lasted several hours

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No relation to meals, but if he ate much the pain was more severe. He grew progressively more constipated. About three months previous to admission he began to lose strength and appetite. He lost nine pounds in three months previous to admission. His pain had increased in duration and his abdomen had become distended. He had noticed a lump in his left lower abdominal quadrant. No blood in stools.

On physical examination nothing was found which bore directly on the abdominal condition except that he had a movable mass in the left upper quadrant which extended downward and inward. The abdomen was soft and there was slight tenderness in the epigastric region. There was a left inguinal hernia and a right hydrocele. After a test meal there was present 21 per cent free hydrochloric acid. On June 21, 1927, he was transferred to the Surgical Service, Division A. June 22, 1927, he received 500 c c of blood transfused. June 24, 1928, he was operated upon by Doctor Green and Doctor Cattell for resection of the tumor. About eighteen inches from the ligament of Treitz was found an annular firm mass about the size of a bantam's egg, having a nodular surface near the mesentery about the size of a hazel nut. This was of a reddish-gray color. Just above the tumor the intestine was intussuscepted over the mass for a short distance (2 cm). This was easily straightened. There was no evidence of inflammation present except a small amount of free fluid in the abdominal cavity due probably to irritation. About five inches of the jejunum were removed with the tumor and with a V-shaped portion of the mesentery. The stumps were crushed, tied and inverted with purse-string sutures and a side-to-side anastomosis performed. He made an uninterrupted recovery and was discharged improved seventeen days after his operation.

The pathologist, Dr. L. C. Knox, called the tumor a leiomyoma of the jejunum. After a description of the morphology, the following sentence concludes the report: "The tumor is of the type which might be expected to recur rapidly if not entirely excised, but which metastasizes only late."

RESECTION OF THE PYLORIC END OF THE STOMACH

DR. NATHAN W. GREEN presented a woman, age forty-four years, who was admitted to the Memorial Hospital, May 20, 1927. Her illness began in March, 1927, with pain in the lower left quadrant and changes in the menstrual period and increasing vaginal discharge. About the same time she began to have gastric symptoms. Eructations of gas and acid fluid, no vomiting, associated both before and after meals with pain in upper right quadrant and epigastrium. Her appetite was fair but she was afraid to eat. Examination on admission showed the upper half of the abdomen negative, all her symptoms were referable to lower part, left and right, where there was some tenderness. Pelvic examination showed presence of a small fibroid left and anteriorly. An X-ray taken May 25, 1927, by Doctor Herendeen showed a constant filling defect in the prepyloric region. The remainder of the stomach appeared normal. Only a trace of barium remained at six hours. Hyperactivity in the colon. Examination of the colon was negative. Wassermann reaction was negative. The result of test meals: May 23, 1927, showed 15 free hydrochloric acid, 90 total, negative for blood. May 26, 30 free hydrochloric acid, total 60, lactic acid negative.

Urine examination on May 26 showed (phenol-sulpho-phthalein) first hour, 10 per cent, second hour, 20 per cent, total, 25 per cent. Blood urea nitrogen on May 26, 7.2 mgm. Hæmoglobin, May 24, was 80 per

RESECTION OF THE PYLORIC END OF THE STOMACH

cent—red blood cells 3,880,000, white blood cells 7,400 June 13, 85
 per cent—red blood cells 4,400,000, white blood cells 12,600 June 17,
 75 per cent—red blood cells 4,112,000, white blood cells 13,600 July
 1, 85 per cent

Operation June 15, 1926, by Doctors Green and Adair, partial gastrec-
 tomy taking pylorus with it and repair by modified Billroth No 1 under

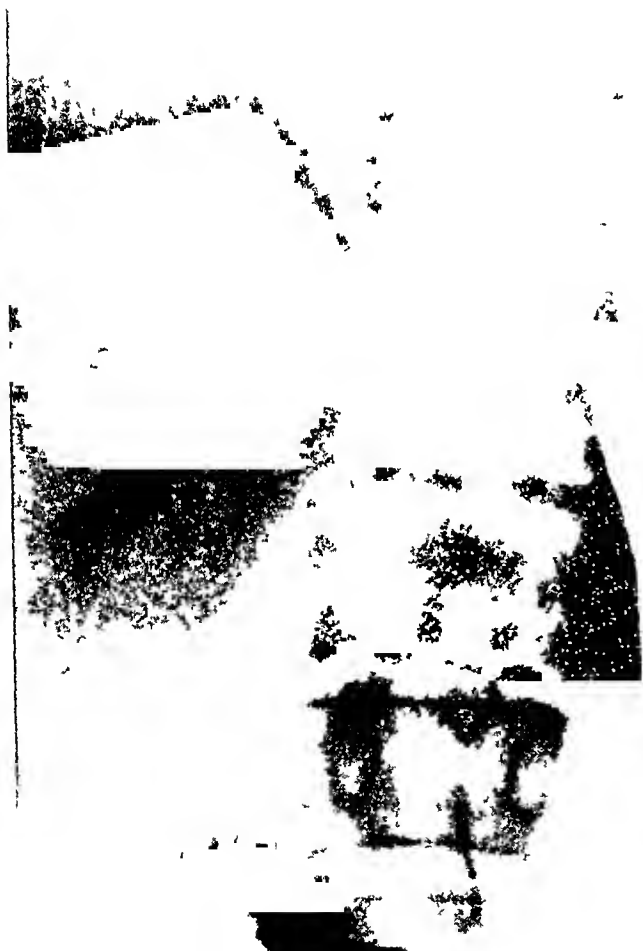


FIG 2—April 19, 1928 Ten months after operation. Showing rapid and satisfactory emptying of stomach. There was no four hour residue

gas oxygen and ether anæsthesia. Time of operation was one hour and fifty minutes. An excerpt from the pathological report said "no gross evidence of carcinoma seen. Stomach shows marked hypertrophic gastritis with broad flat ulceration. The base of the ulcer is infiltrated with alveolar and diffuse carcinoma. Diagnosis Ulcerating gastric carcinoma, lymph-nodes free"

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Specimen measured 7 by 4 cm pyloric end of stomach and 2 cm duodenum Ulcer 1 by 1 cm The patient was discharged without incident July 4, 1927 At intervals beginning July 16, 1927, she received irradiation by the radium element pack, extending over forty-one days, 90,000 millicurie hours divided about evenly (five anterior pyloric region and five posterior pyloric region) The number of millicuries in the pack was 4,000 The maximum time of administration was three hours The filter was 2 mm brass and $\frac{1}{2}$ mm platinum The distance was uniformly 15 centimetres April 18, 1928, her hæmoglobin was 80 per cent—red blood cells 3,960,000, white blood cells 6,600 On the same day she looked pale but had gained weight and was vigorous She had gained thirty-two pounds since her operation according to her observation Weight April 18, 1928, was 136 pounds, which was twelve pounds above her normal state of nutrition

DR CONSTANTINE J MACGUIRE, JR, referred to a patient he had shown before this society a year ago as a good result of a resection with end-to-end anastomosis for annular carcinoma of the jejunum The patient, however, died recently of metastasis The patient was shown one year after the resection He felt that there was a poor prognosis in Dr Green's case

LUNG ABSCESS—TWO-STAGE DRAINAGE OPERATION

DR NATHAN W GREEN presented a woman, age forty-three, who was admitted to the Medical Service, St Luke's Hospital, April 30, 1927 Chief complaint was cough and sputum Nine months previous to admission she had an attack of pneumonia and was in bed for five weeks Then she went to work, but a slight cough persisted This did not trouble her much and she was not raising any sputum so she let it go until December, 1926, five months ago, when her cough increased, became harsh and she began to cough up phlegm-like material with lumps of greenish pus Also with the most violent attacks of coughing she would have a pain in her left side posteriorly similar to the one she had when she had pneumonia She went to the mountains, her cough and expectoration continued and her sputum began to be blood-tinged and continued so until admission to the hospital She grew somewhat weaker and "lazier", but gained weight and said she did not have any fever Three weeks previous to admission after an exceptionally bad coughing spell she said she spit up a large pus basin full of the bloody sputum

Physical Examination—Breath sounds slightly increased at the angle of the left scapula She was bronchoscoped May 11, 1927, and 10 cc lipiodol injected and then sent to the X-ray room She was discharged June 13, 1927, improved The X-ray report dated May 11, 1927, read as follows The shadow originally described has become subsequently somewhat larger and of a more indefinite outline with an area of evident disintegration near its centre, lying between the shadows of the first and second anterior ribs It is thus much more characteristic of a pulmonary abscess July 6, 1927, X-ray shows "the external circumference is about the same size There is a slightly greater degree of cavitation near the centre of the shadow" Four times the sputum was found negative for tuberculosis Three times the sputum was found negative for streptothrix Her Wassermann reaction was negative Following two injections of salvarsan 0.3 gm the temperature dropped at first to 100° and then to normal She was discharged June 13, 1927, with the following note "At discharge the patient seems much better although she still continues to spit blood and much pus X-ray shows that

HÆMATOMA IN SHEATH OF RECTUS ABDOMINALIS

process is healing. It is thought that the salvarsan helped the condition—although spirochaetæ were never demonstrated.”

June 30, 1927, she was again admitted to the hospital with the observation that she had been raising some blood until three days before readmission and had been raising five or six ounces of sputum a day. On reexamination the left lung was found slightly dull throughout, but particularly so in the upper lobe. August 18, 1927, she was transferred to the Surgical Service of Division A. August 19, 1927, under ethylene anesthesia, the first stage thoracoplasty was performed by Doctor Green. The incision followed the course of the fourth rib. Portions of the third, fourth and fifth ribs were resected subperiosteally on the left side. Gauze was packed into the wound extensively to produce wide adhesion between the two layers of pleura, and pressure was applied to collapse the lung to a slight degree.

August 30, the second stage for drainage of the abscess was carried out. The packing which had remained since the previous stage was removed and the lung through the adherent area was explored with a needle and this was followed by blunt dissection. The walls of the cavity which was irregular were broken down and the cavity packed with iodoform and plain gauze. No cautery was used. The iodoform gauze was placed *in situ* for the purpose of casting a shadow by the X-ray. The patient remained in the Surgical Service until December 20, 1927, when she was discharged to a convalescent home with the following note: “Patient had first stage thoracoplasty done August 19, 1927, and ten days later the second stage. Temperature remained elevated and patient drained properly and expectorated large quantities for weeks, was up in chair daily for short time after about ten days. Had periods of relatively high and low temperature for about eight weeks. On sixty-fourth day developed pneumonia which subsided in about a week and temperature came down to normal to remain. Was given four doses of neo-salvarsan at weekly intervals and rapid improvement was noted. Discharged to convalescent home. Bronchial fistula present, no cough, little drainage and no sputum or drainage.”

HÆMATOMA IN SHEATH OF RECTUS ABDOMINALIS

DR FORDYCE B. ST. JOHN presented a woman, thirty-five years of age, who was admitted to the hospital of the Rockefeller Institute March 12, 1926, complaining of sore throat, pains in the chest and cough for three days. The past history was negative except for an operation for uterine tumor eight years before and chronic constipation.

Upon admission, the temperature was 103, pulse, 104, respiration, 23. There were no definite signs in the chest. Throat was red. Urine negative. White blood cells 3,800, polymorphonuclears, 87 per cent.

Eight days after admission the patient complained of pain in the right lower quadrant, lasting for several hours. Examination of the abdomen was negative. Two days later, while leaning over in bed, the patient complained of very severe pain in the same location, and upon examination a very tender swelling in the region of the right rectus was noted. This persisted and was associated with moderate rigidity of that quadrant. White blood cells, 8,100. Temperature, 98.5 to 100°. Pulse, 80 to 88. The next day the pain was somewhat less but the tenderness over the mass was more marked. He saw the patient at this time and found the abdominal wall relaxed, except the lower half of the right rectus where a firm mass presented, which was very tender. Pelvic examination was negative.

A lower right rectus incision made over the mass revealed a hæmatoma in and around the rectus muscle, consisting of old and darkened blood

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clots, infiltrating the muscle, and measuring 6 by 2 by 3 centimetres. The clot was evacuated and cultured, after which the posterior sheath was opened, the peritoneal cavity explored and found to be normal. The appendix was removed. In the closure a small rubber drain was left in the region of the clot. Microscopic report of the appendix showed it to be relatively normal.

At the present time, after two years, the wound is firm. Patient slightly constipated with occasional attacks of indigestion.

TRAUMATIC OSSIFYING MYOSITIS

DR FORDYCE B ST JOHN presented a girl, twenty-one years of age, who was admitted to the Presbyterian Hospital August 10, 1926, complaining of pain in the right gluteal region.

About twelve weeks before admission the patient suddenly experienced a sharp but not very severe pain in the right buttock. This persisted for several days, causing her to limp while walking. Rest in bed caused temporary relief, but the pain recurred when she began walking again, only to disappear with rest as before. She remembered no trauma, no infection or abrasion of the foot or extremity. She had had no recent boils. There were no constitutional symptoms except for a slight loss of weight. She had noted no lump or deformity, but had been told that one was present. Within the two weeks just previous to admission the pain had not responded to rest in bed.

Additional information presented by the patient's brother, a physician, was to the effect that the pain was referred to the knee, calf and heel, that a complete neurological examination had been negative, and that many forms of conservative therapy had been of no avail.

Physical examination revealed a well-nourished young female. The general examination was negative. Locally there was found in the region of the right gluteus maximus a firm, hard tumor, very slightly tender, and apparently firmly attached to the deeper structures. The gluteal fold had disappeared. Motion at the hip was practically normal. The tumor roughly measured 10 by 15 by 10 centimetres.

X-ray examination revealed a loosely arranged spherical bony mass, with delicate trabeculae, apparently not attached to the femur or ileum.

August 12, 1926, a long oblique incision in the direction of the fibres of the gluteus maximus was made. The fibres appeared pale and atrophic. A tumor mass, globular in nature, measuring 10 by 6 by 6 centimetres, was found incorporated in the maximus and medius muscles, intimately associated with, but not actually attached to the capsule of the joint. The mass was removed with care, along the sciatic nerve, upon the sheath of which it was resting.

Pathological examination shows a lobulated, well-defined mass of cancellous bone, 6 by 4.5 by 6 centimetres. For the most part this is encapsulated by a well-defined plane of connective tissue, but there are two or three small areas of bone formation outside the main mass, and near these the capsule is not so well marked. The interior of the bony mass is made up of fibrous tissue. The bone is sufficiently soft to be cut with a sharp knife. Microscopic examination showed actively growing bone trabeculae, separated by very cellular loose connective tissue, stroma in which there are great numbers of blood-vessels. No cartilage is seen. In the capsule of the tumor, with van Gieson's stain, remnants of striated muscle are seen. Sections of muscle beyond the tumor show degenerative changes similar to those in the capsule of the tumor.

Diagnosis—Traumatic ossifying myositis. (Note. As there is no clin-

TRAUMATIC HÆMOTHORAX

ical history of trauma, this diagnosis is perhaps not entirely justified. The pathological evidence is degenerated muscle and hetero-plastic bone. (Dr Kneeland Fiantz.)

Follow-up — (Five months) Patient feels well. Is active. No pain. Right thigh is as strong as the left. Examination reveals a good scar, movable, no tenderness or induration, no evidence of mass.

TRAUMATIC HÆMOTHORAX

DR FORDYCE B. ST. JOHN presented a boy, twelve years of age, who was brought to the Emergency Department of the Presbyterian Hospital January 18, 1925, with the following history:

Ten minutes before coming in he had lost control of his sled while coasting in the park and had run into a tree, the side of the sled striking him on his left side. Almost immediately he vomited. A passing pedestrian advised him to come to the hospital.

Examination revealed a boy obviously suffering from a moderately severe grade of chorea. There was no evidence of head injury. The chest was entirely negative and there was no ecchymosis or tenderness over the ribs. The abdomen was soft, with no tenderness to be elicited. The patient was referred to the clinic the following day, however, for further observation.

He returned to the clinic, as advised, and a complete examination failed to reveal evidence of injury, lungs and abdomen being negative. At this time the patient was seen by one of the visiting physicians and was told to return in one week.

Four days later, he was brought in with a temperature of 103, pulse 104, respiration 42. He was coughing, and was obviously acutely ill. Blood count 27,300, polymorphonuclears 76 per cent, red blood cells 4,360,000, hæmoglobin 85 per cent. Examination showed diminished respiratory excursion of the lower left chest with no tenderness. There were typical signs of fluid in the lower left chest. The heart had apparently not shifted. The abdomen was soft.

Aspiration of the left chest revealed 150 c.c. of dark blood-stained fluid, with negative culture. The blood culture also was negative. Three more chest taps within ten days all showed foul-smelling, old, bloody fluid, with growth of hæmolytic staphylococcus aureus. The temperature remained up. White blood cells around 23,000. The patient was transferred to the surgical service, where two more aspirations revealed the same foul-smelling pus.

February 12, 1925, an incision was made over the eighth and ninth ribs in the left posterior axillary line. Aspiration over this site gave one the sense of passing through semi-solid tissue and resulted in the recovery of foul, reddish exudate. After sub-peritoneal resection of portions of the eighth and ninth ribs, the parietal pleura was incised, with the escape of no exudate. Inspection of the pleural cavity revealed no collection of pus, but there were freshly-formed fibrinous adhesions. The diaphragm was then incised, and the sub-phrenic space found to be clear of infection. The left lobe of the liver was aspirated, and on the third attempt, the same foul-smelling reddish exudate as had previously been obtained was obtained at a depth of 2.5 centimetres. The pleural cavity was closed off, except for individual air-tight drainage, the diaphragm sutured to the parietal pleura, and the liver abscess drained. Culture of the pus showed hæmolytic staphylococcus aureus.

After a stormy course, which was prolonged, including two explorations of the liver sinus tract in search of walled off pockets, the patient made a complete recovery.

Follow-up — (Thirty-nine months) Chest is essentially negative. The

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boy apparently is normal, except for his constitutional type and obesity, having gained 125 pounds since operation

HÆMATOMA OF THIGH AND PELVIC REGIONS

DR FORDYCE B ST JOHN presented a woman, fifty-one years of age, who was admitted to the Presbyterian Hospital April 15, 1928, with the following history

The patient presents a history of congenital dislocation of both hips, which has caused surprisingly little discomfort or inconvenience. She has led a very active life, walks with but a very slight limp, has always done her own housework, and has been married for twenty-four years. She has been pregnant six times, with five full-term babies. Two of her children are living. Until onset of the present illness she has enjoyed dancing and skating among her other activities.

Two years ago she noticed a slight pain which resulted in extensive ecchymosis and swelling of the left inguinal region and the upper one-third of the thigh. This appeared spontaneously and disappeared with rest in bed, leaving no after effects.

Seven months before admission she again noticed ecchymosis in the left femoral and inguinal region with very little swelling and pain. Rest in bed was followed by complete disappearance of symptoms.

Two months before admission, during the act of defecation, she experienced very great pain in the lower left abdomen, inguinal and femoral regions. She noticed swelling in the inguinal region, and later ecchymosis.

When first examined there was a definite mass on the antero-lateral aspect of the upper femoral and inguinal regions, apparently continuous with a mass on the left lateral aspect of the pelvis. Vaginal examination was negative. There was slight tenderness over the mass and no ecchymosis.

X-ray examination showed a dislocation of both femora and absence of heads. The remaining portions of the necks of the femora articulate with the ileum. In addition, the upper half of the shaft of the left femur is decalcified and the cortex quite irregular. This process seems to begin about at the level of the lesser trochanter and extends downward for a distance of about 5 centimetres. Soft shadows can be seen radiating outward from the cortex around the entire circumference of the bone.

Exploration revealed a very large hæmatoma deep to the vastus externus, rectus femoris, and femoral vessels, extending along the iliacus muscle and retro-peritoneal tissue. Pressure over the lateral pelvis expressed clots into the wound. The upper extremity of the femur was inspected on its anterior aspect and carefully palpated, but no gross evidence of neoplasm could be made out. The large blood clots were expressed, loose packing gently inserted, with a soft drain.

Pathological examination of the material removed has failed to show evidence of neoplasm, nothing but blood clot being noted. Convalescence has been uneventful.

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CANCER OF TONGUE AND FLOOR OF MOUTH

sion that treating the syphilis makes the patient worse and these patients do not do well. There are of course exceptions, where there is a question of diagnosis, the pathological report of the biopsy being chronic inflammatory tissue and the lesion being atypical of carcinoma. The therapeutic test of specific treatment is instituted until the diagnosis is proven to be cancer or syphilis.

Biopsy or tissue examination from operative specimens was made in seventy-one of the patients. This low incidence is due to the fact that many

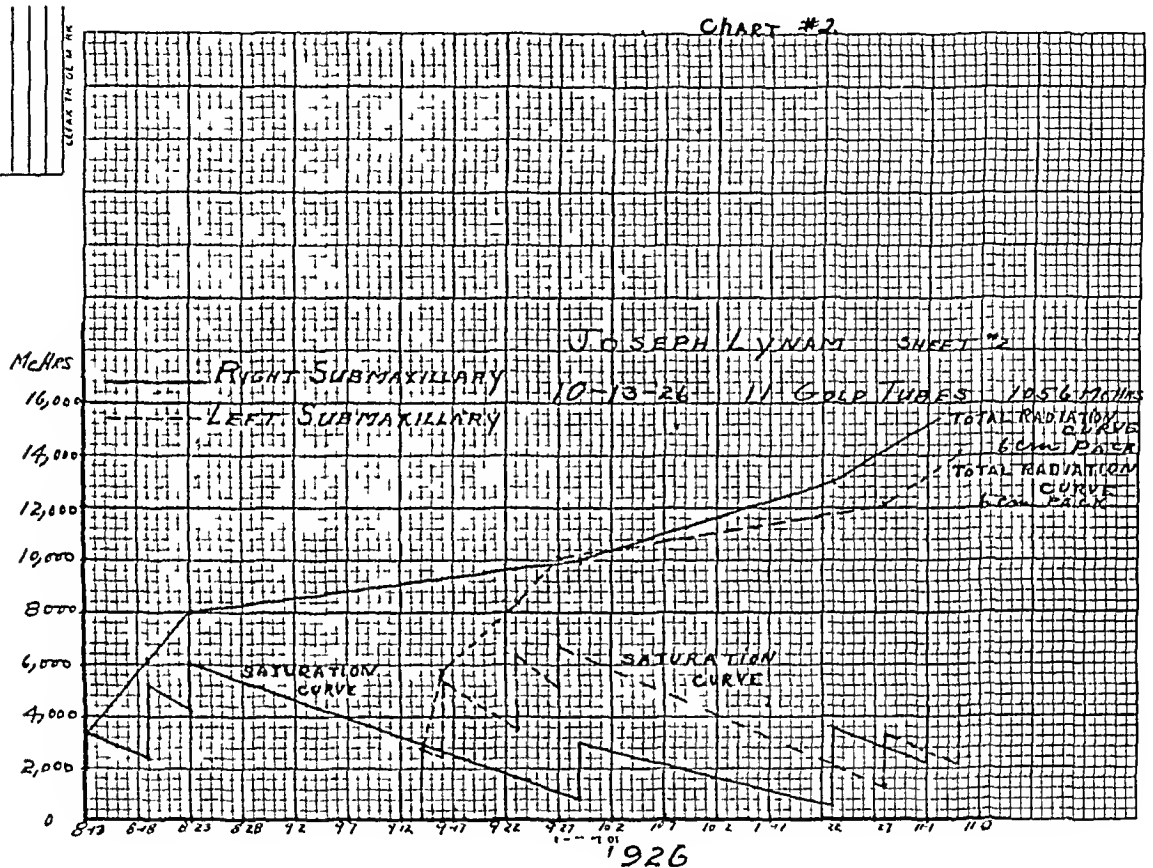


CHART 2 is a continuation of Case I. It is to be noted that no radiation was given from May 3 to August 3. During the period from August 3 to November 2, 1926, 15,200 millicurie hours were given to the right submaxillary region. During the period from September 14 to November 4, 14,000 millicurie hours were given to the left submaxillary region. Gold tubes were implanted in the local lesion on October 13, 1926, amounting to 1,050 millicurie hours.

of these cases were in a hopeless and dying condition when first referred to the Philadelphia General Hospital. We did not feel justified in taking biopsies from these patients as the diagnosis clinically was self-evident and they were too far advanced for any treatment.

It is our strict rule, however, that all patients whom we treat must have one or more biopsies until the diagnosis is proven. We would like to emphasize the necessity of a pathological confirmation of the diagnosis of cancer in every patient before he is treated.

In a certain number of cases we were unable to prove the diagnosis of cancer and these gave us our most brilliant results. They are not included in this series for that reason. We have had quite a number of cases sent to us

DORRANCE AND McSHANE

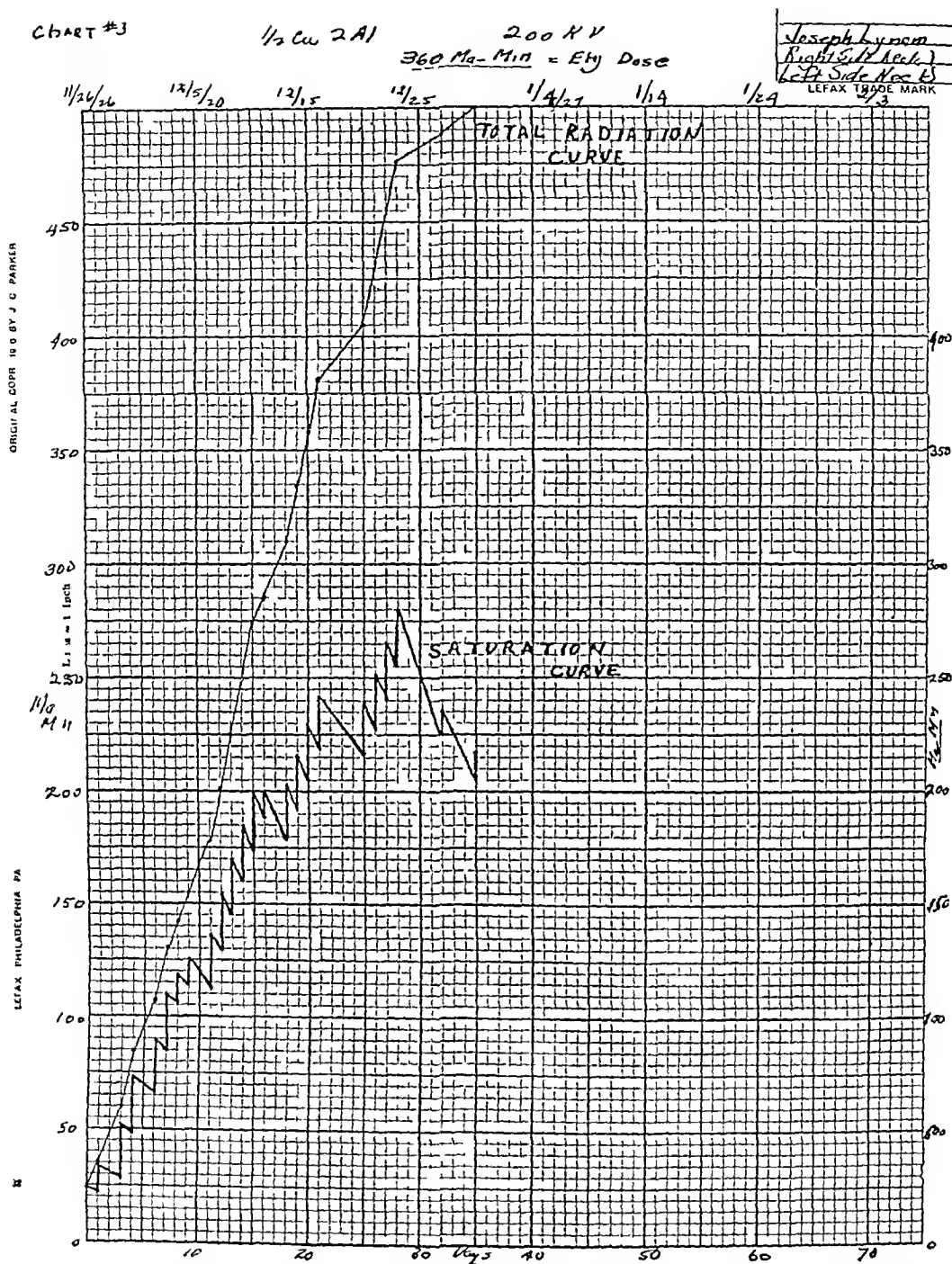


CHART 3 is a continuation of the treatment of Case I. These curves, however, are for X ray. As the case was not progressing favorably under radium treatment, a course of X ray was next tried. The machine factors and the filters are given at the top, the region will be noted in the right hand corner at both sides of the neck. In the curve itself the abscissa represents the days and the ordinate millirampere minutes. The light line represents the total radiation and the heavy line the saturation curve. It is to be noted that while a total of 500 millirampere minutes was given in thirty five days time, the saturation curve never approached the erythema dose of 360 millirampere minutes. This is due to the fact of the previous radium irradiation. This curve is continued in Chart 4.

CANCER OF TONGUE AND FLOOR OF MOUTH

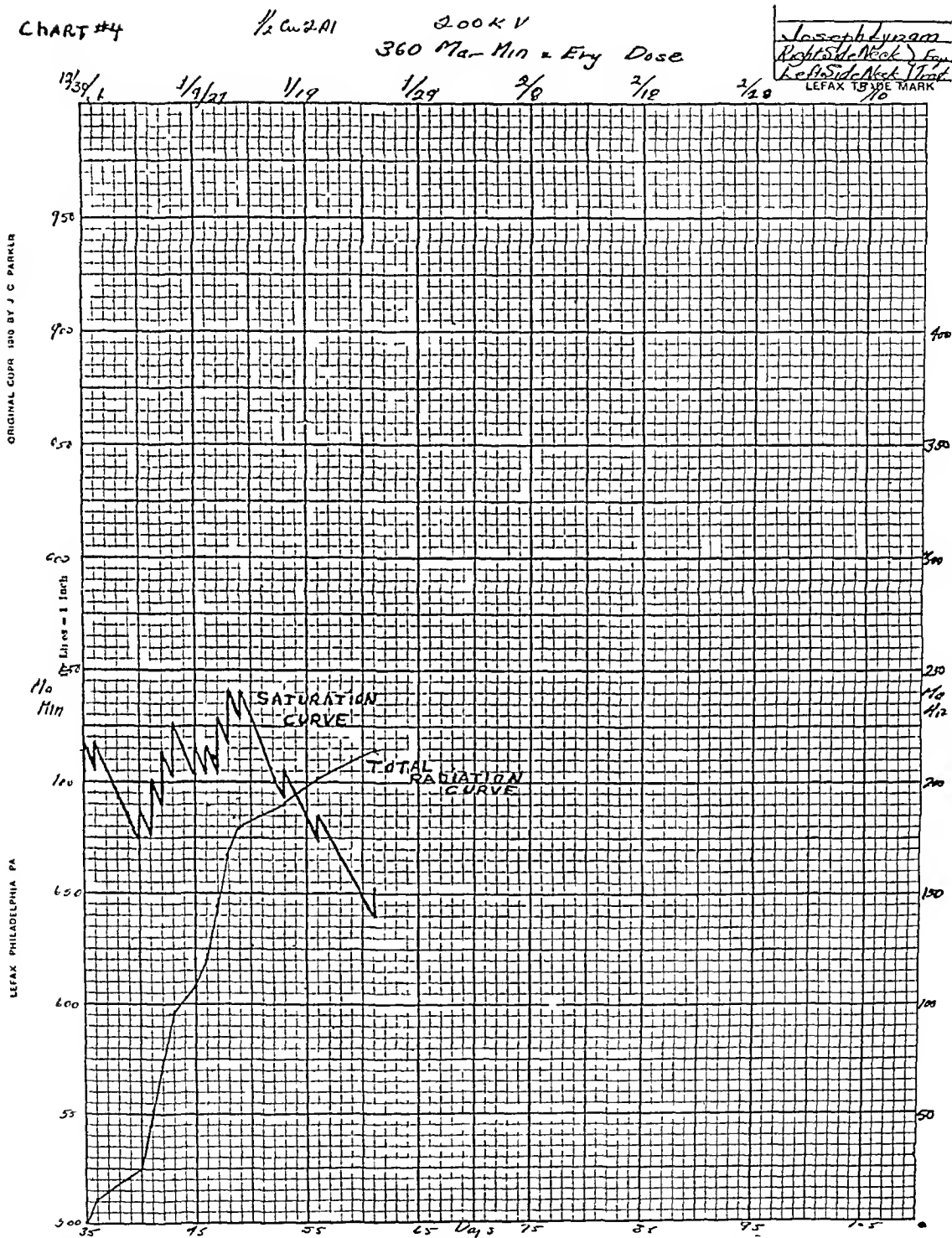


CHART 4—Continuation of the treatment of Case I. Note that 715 milliamperere minutes' irradiation were given and that saturation curve ranged between 200 and 250 milliamperere minutes. Despite this irradiation the case had a fatal termination. A bilateral ligation of the external carotid arteries was done on September 2, 1926.

with a diagnosis of cancer that turned out to be syphilis, tuberculosis or actinomycosis

Of the seventy-one patients with pathological examinations, the diagnosis was positive in sixty-two cases, although multiple biopsies were required in several of these. Of the remaining nine cases, chronic inflammation was reported.

Of the positive biopsies, twenty-five were squamous-cell and thirty-seven were prickle-cell carcinoma.

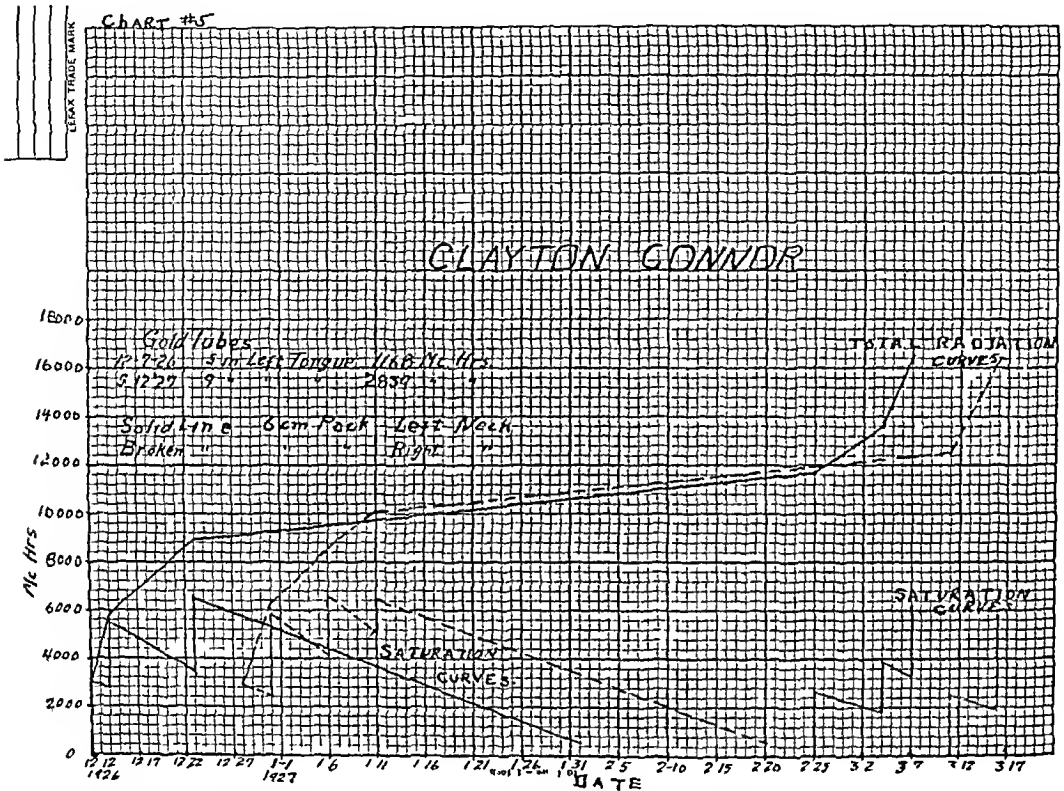


CHART 5—Treatment of Case II. This patient lived six months and had a prickle cell carcinoma of the tongue and glands at the angle of the left jaw. Local treatment of the lesion by means of gold tubes is given at the upper left hand corner. The curves are self explanatory.

Within the last year, Doctor Belk, pathologist to the Radiologic Clinic, has been grading these cases according to Broder's classification but this is too recent for us to draw any conclusions as to their clinical course from this classification.

Of the 164 cases, twenty or 12 per cent were admitted in a dying condition and lived from one day to three weeks. Another group of eighty-five or 51 per cent presented marked cachexia, extensive primary involvement and widespread neck metastasis when they first came under our care. They received moderate mild radiation as palliative treatment and died in from one to six months. There were twenty-seven or 16.4 per cent patients who lived from six months to one year.

Analyzing this group we find that twenty-four presented neck metas-

CANCER OF TONGUE AND FLOOR OF MOUTH

tasis on their admission. Of the remaining three cases, one left our care and had an excision of the tongue at another hospital and returned four months later with hopeless neck metastasis not having received any radiation in the interval. He died in less than one month not having been treated by us. The other two patients did not show any neck metastasis on their admission but nevertheless died in one year.

The treatment in this group ranged from mild local and regional irradiation to very thorough and complete irradiation, as we will show subsequently with lantern slides.

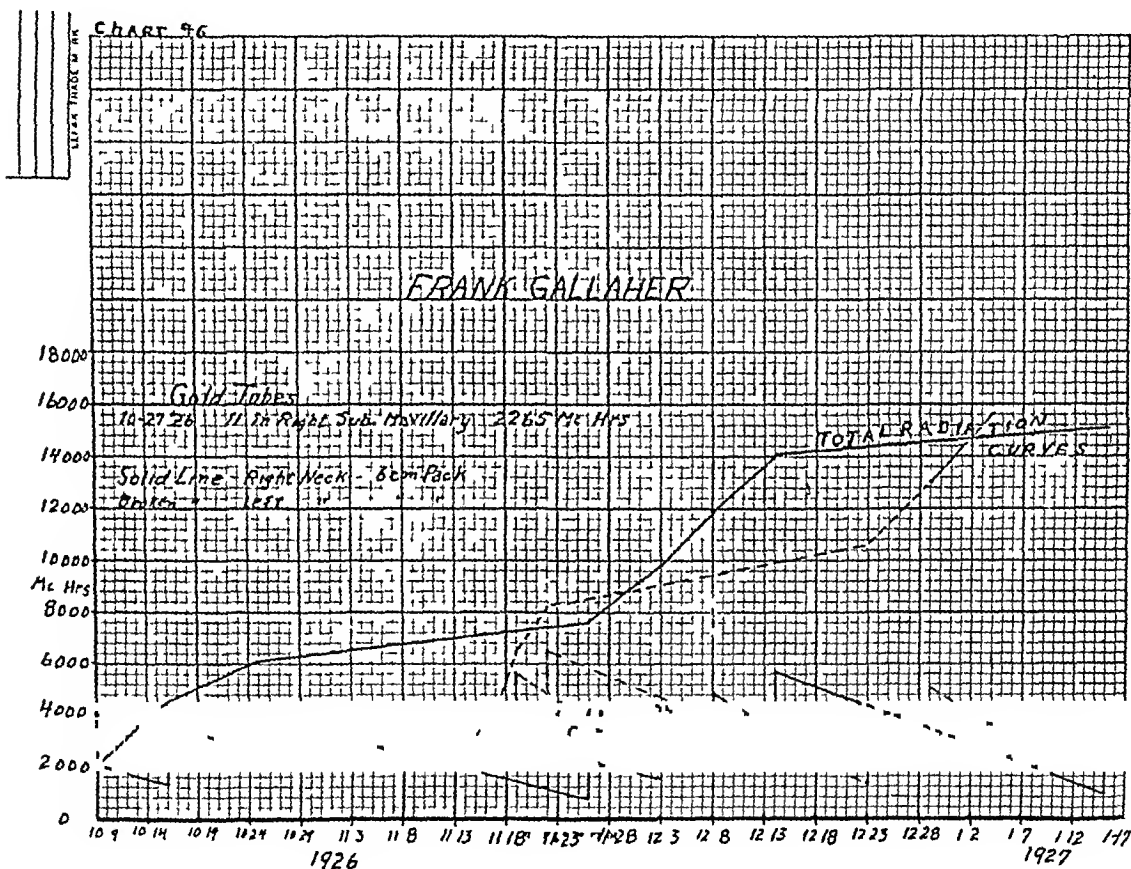


CHART 6—Represents the irradiation of Case III. Age sixty five. Lived eight months. When he first came under our care his primary lesion, floor of mouth, had been treated at another hospital. He showed a large submental mass and an entire disappearance of the primary lesion. The curves show the total amount of irradiation to both sides of the neck and the amount given by the saturation method. Besides this it will be noted that gold tubes were implanted in the right submaxillary region, a total of 2,265 millicurie hours.

In the group that lived from one to one and one-half years, there were seven or 4 per cent.

All of these cases with the exception of one, died. This living patient has shown marked regression of his disease, and it is at least temporarily controlled.

Three patients have lived between one and one-half and two years and they are all still alive. Two of these showed fairly far advanced primary lesions and enlarged submaxillary or anterior cervical glands. The third was an early case of the floor of the mouth with some thickening of the underlying submaxillary gland. Two of these patients are entirely free from all

evidence of disease (Potts and Stengel), the third had malignancy present when last seen but it seemed to be quiescent. He lives up the state and we have been unable to have him return for further treatment.

Two patients lived over two years but finally died of their cancer despite very active radiation. One showed neck involvement on admission, the other did not. They were both undoubtedly benefited by radiation. Two cases lived over three years. Both showed moderately advanced submaxillary and submental glands. They were thoroughly radiated and their lives were pro-

U.S. PAT. TRADE MARK

CHART #7

LOUIS RAINSEUM

DATE	McHrs.	POSITION	APPLICATOR
1-10-24	88.00	SUBMENTAL	GRAY PACK
1-18-24	47.70	"	"
1-24-24	4.80	ON LESION	PENTAL COMPOUND
2-7-24	11.62	IN LESION	GRAY TUBES
3-15-24	39.08	SUBMENTAL	GRAY PACK
3-29-24	40.56	"	"
4-12-24	34.20	"	"
11-23-24	18.05	LYMPHATIC NECK	GRAY PACK
1-2-25	21.42	UNDER CHIN	GRAY PACK

CHART 7—Represents the irradiation of Case IV. Age fifty four. Lived one year and one month while under our care. He had an extensive lesion of the floor of the mouth and a few enlarged submental glands. His irradiation being spread over one year's duration, could not easily be plotted in a curve so it is presented in tabulated form.

longed by the use of radium. Life was prolonged for five years and seven months in one patient by irradiation before he finally succumbed to his cancer. The remaining cases will be discussed later when we consider our arrested cases.

Autopsies were performed in fifteen of the patients. None of these cases showed metastasis beyond the neck. This is particularly interesting to us as we have at present a patient who shows complete disappearance of his primary lesion at the tip of the tongue, one hard stony gland in the left side of his neck apparently inactive and yet his liver is very markedly enlarged and has the characteristics of metastatic cancer. Nine of the autopsied patients showed severe pneumonia—purulent in some cases and multiple lung abscesses in others.

CANCER OF TONGUE AND FLOOR OF MOUTH

One patient died of retropharyngeal abscess, 150 c c of pus being evacuated at autopsy

As to the cause of death we find that twenty patients had one or more hæmorrhages from the mouth or neck and nine patients bled frequently and severely enough to die of the effects of hæmorrhage

We had five operative deaths in the series. We found that we must do all possible operative procedures under local anæsthesia, our patients being usually poor operative risks

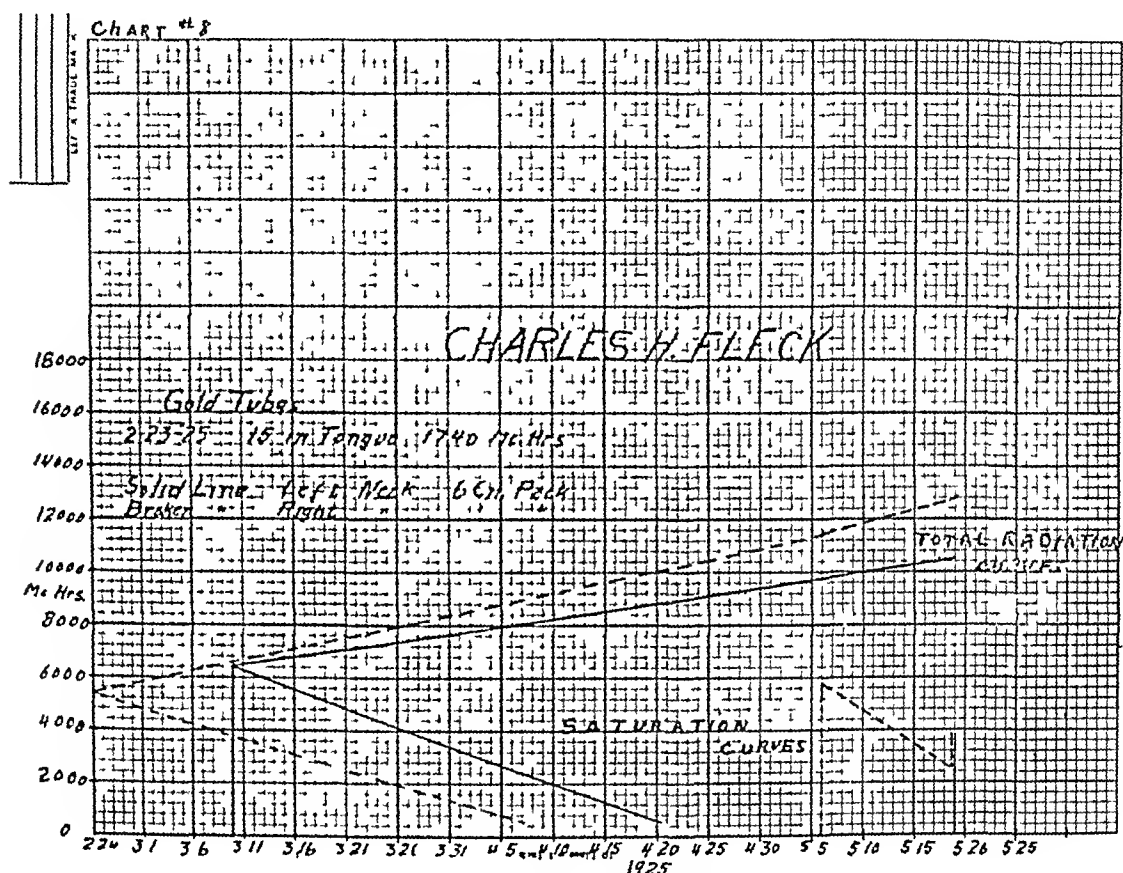


CHART 8—Represents the irradiation to Case V. Age forty four. Lived seven months. This patient was first treated for syphilis by his family physician who finally referred him to another hospital where a biopsy was taken and radium treatment given. He was finally referred to us with two ulcers of the tongue. We advised excision of the tongue which was refused. Biopsy showed squamous cell carcinoma. The curves show that this patient was not treated as vigorously as the preceding cases. In fact he received only two treatments to each side of the neck of approximately 6,000 millicurie hours each. He rapidly became hopeless and died in seven months.

One patient died the day following incision of the neck and implantation of bare tubes, a second following excision of the tongue, a third after a Janeway gastrostomy, a fourth one day after bilateral ligation of the external carotids, electrocoagulation of the cheek and tongue, and radium implantation around the coagulated lesion. The fifth patient died three days after a bilateral ligation of the external carotids.

In regard to the total operative procedures done of these patients, seven were electrocoagulated, four had a Janeway gastrostomy, fourteen had alcoholic injection or resection of the fifth nerve and the superficial cervicals, ten had unilateral or bilateral ligation of the external carotids.

The low incidence of the electrocoagulation is due to the advanced stage at which we first saw these patients. Nothing short of a total excision of the tongue and a complete block dissection of the neck would remove the malignancy, and the general condition of these patients made such an operation impracticable.

We feel that electrocoagulation has a definite place in the treatment of cancer of the tongue and floor of the mouth, as we will outline later.

Recourse was had to gastrostomies when swallowing became difficult or

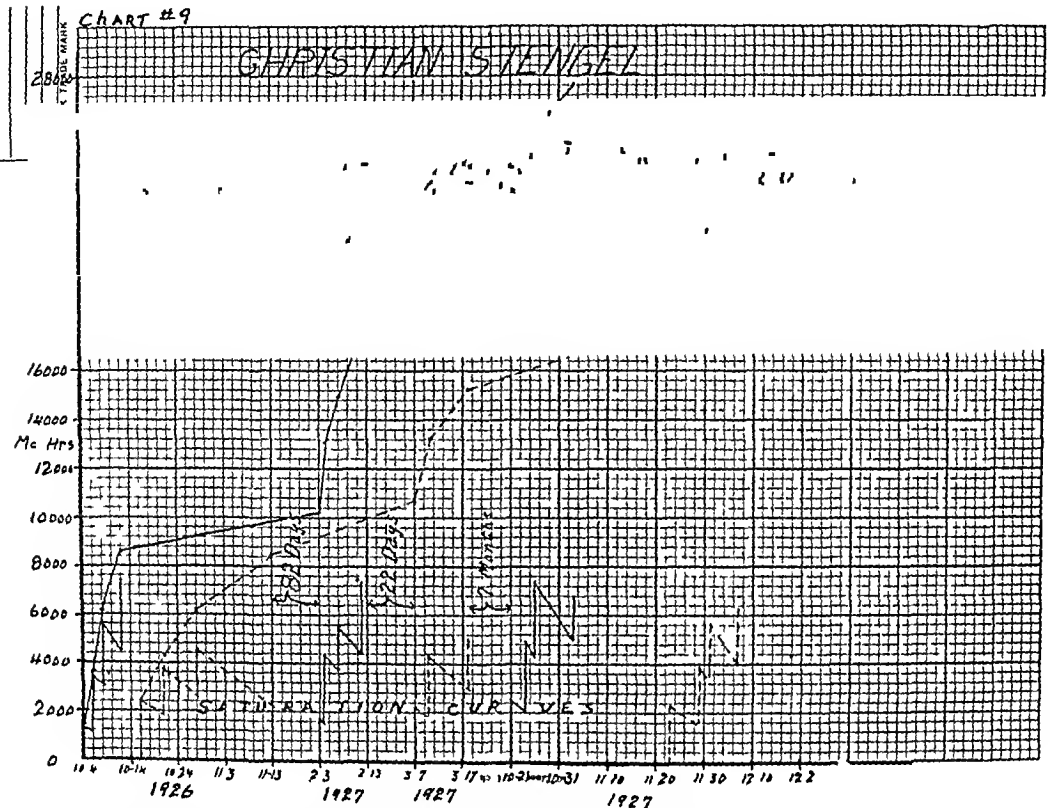


CHART 9—Represents the irradiation of Case VI. Age sixty seven. He first came under our care on September 16, 1926, with a prickle cell cancer of the left floor of the mouth and no demonstrable adenopathy. He is alive to day and free from all evidence of cancer. A study of the curves will show that he got four series of neck irradiation. The treatment of the local lesion by means of glass tubes and later gold tubes is given in the upper left hand corner.

impossible. However, this was used only as a last resort as nasal or oral feeding through a Rehfuß tube was practiced as long as possible. This greatly decreased the number of gastrostomies and the importance of doing this will be recognized when we note that two of the four patients died, one the day of the operation and the other four days later.

Probably the greatest help we were able to give these patients in their advanced stage of cancer was the relief of their pain.

In the lesions of the tongue, floor of the mouth and neck, we have mainly to deal with the nerve supply through the third division of the fifth nerve and the branches of the cervical plexus. As these patients do not have a very long span of life, we have been content in most instances with the extracranial

CANCER OF TONGUE AND FLOOR OF MOUTH

operations. However, in two of the cases a craniotomy and cutting the sensory root of the fifth nerve was performed, six had alcoholic injection of the Gasserian ganglion, five had alcoholic injection of the third division at the foramen ovale, one had alcoholic injection of the lingual nerve, and seven had resection of the branches of the cervical plexus.

All of these patients were greatly relieved, did not require any more morphine, slept well when previously they had not.

The relief of pain in cancer of the mouth is particularly important because

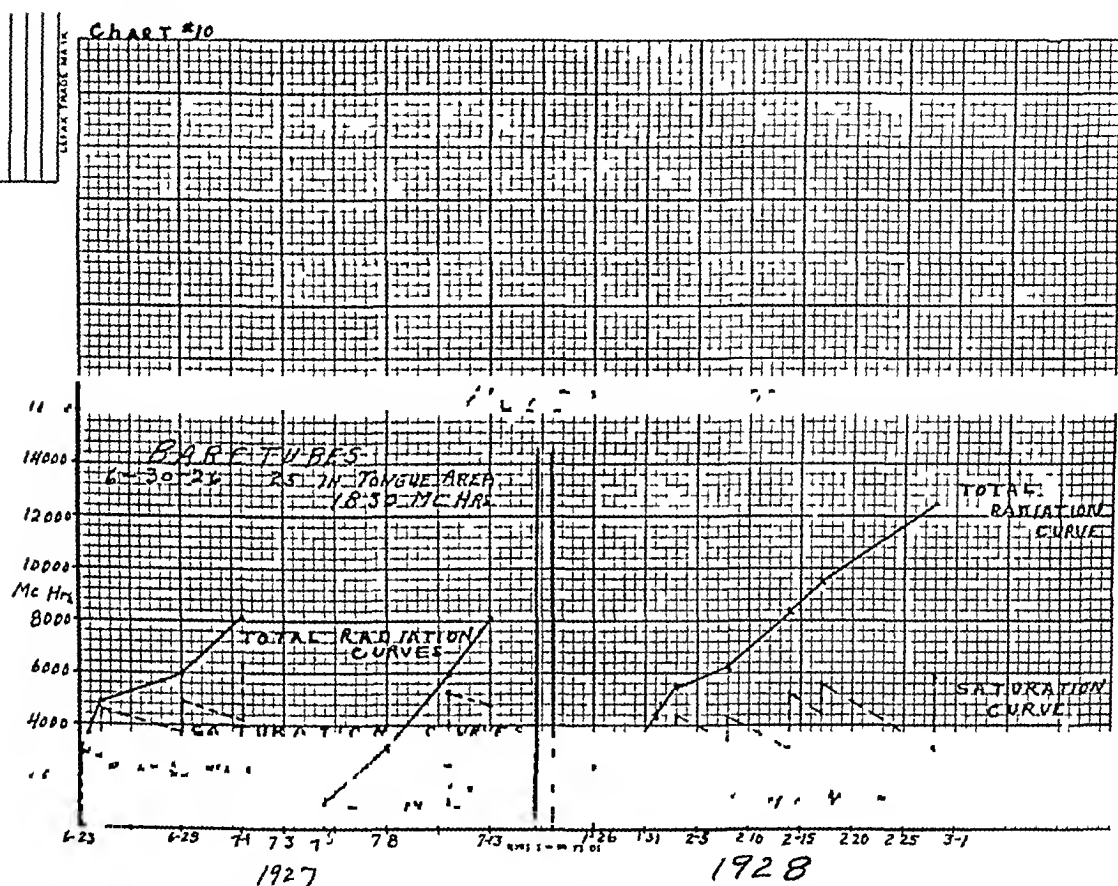


CHART 10—Represents the irradiation of Case VII. Age seventy four. First came under our care June 21, 1926, with a prickle cell cancer of the under surface of the tongue and floor of the mouth and three or four palpable glands in the right side of the neck under the sternomastoid. He is free from all evidence of cancer at present. The curves are self explanatory and the local treatment of the lesion is given at the upper left hand corner.

it enables these patients to sleep and eat when previously they had been unable to do either. Loss of sleep and inability to eat rapidly puts these patients in a very wretched condition and contribute to a rapid and fatal termination.

The measures we have enumerated above do not completely relieve all pain, as some of these patients, particularly those who have had lesions of the posterior one-third of the tongue still complain of pain on swallowing and it is usually referred to the ear. This is probably through the glossopharyngeal and vagus nerves and is very troublesome and very hard to treat.

In some instances where an indurated ulcer is present in the tongue, thorough coagulation will relieve the pain. Deep cervical pain is also present being carried through the deep branches of the cervical plexus which are

mixed motor and sensory nerves It has been our custom to resect only the superficial cervicals which are purely sensory

We recommend unilateral or bilateral ligation of the external carotids in all cases in which severe face or intraoral operations are to be done, as this makes the procedure practically bloodless and so reduces the shock of the operation, the incidence of lung complications and the liability of secondary hæmorrhages We also employ this measure to control the slow, steady ooze which some of these patients show and which lead to very severe secondary

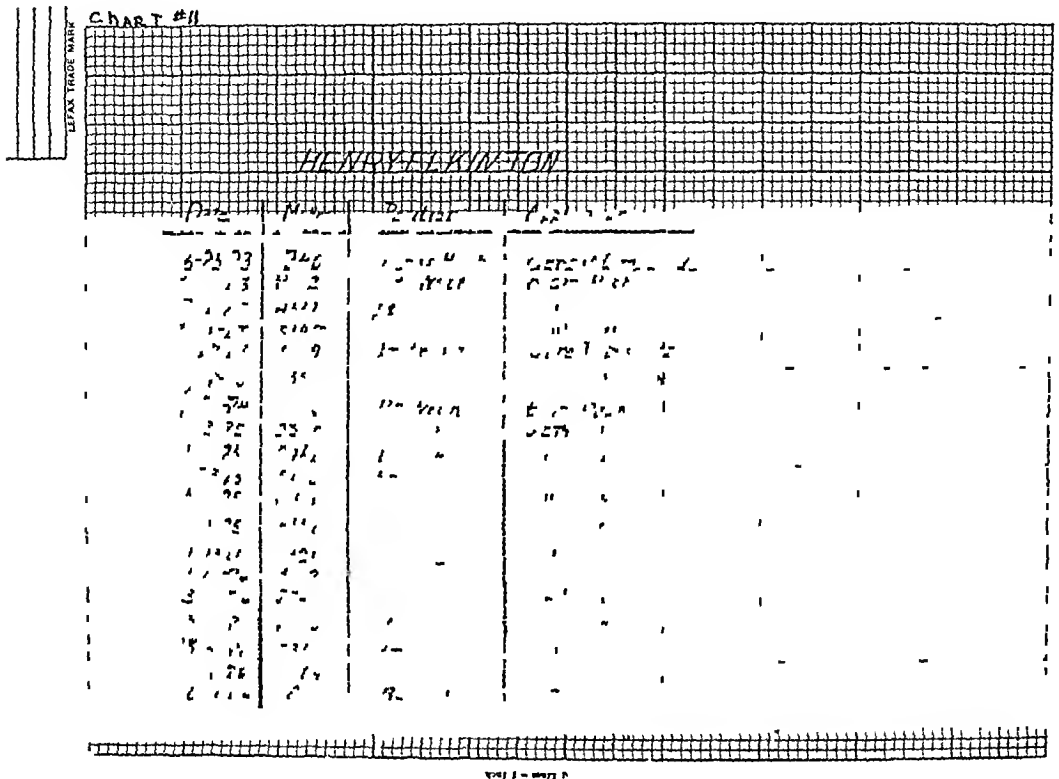


CHART 11—Represents the treatment of Case VIII. Age seventy three. He first came under our care June 25, 1923, with a squamous cell cancer of the floor of the mouth, frenum of the tongue and mucosa of the lower jaw quite extensive. He is now entirely free from all evidence of cancer. His treatment extended over three years and so a curve could not be very easily plotted. The treatment is tabulated above.

anemia, if it is unchecked. Finally we ligate the external carotids to control hæmorrhage in the mouth.

We have done this operation on ten patients in this series and it is very easily and quickly performed under local anæsthesia. One patient died the day of operation but as he also had an excision of the tongue, this death belongs to the latter operative procedure. Another patient died three days following a bilateral ligation of the external carotids, extraction of the teeth and implantation of gold tubes. He received ether anæsthesia, never rallied from the operation, and died in coma. He showed no embolic symptoms. Two patients showed cerebral symptoms. One developed a left hemiplegia after a bilateral ligation of the external carotids which was permanent. He

lived for three months following this. The other patient developed a right arm paralysis, twitching of the right side of the face, and partial facial palsy. This all cleared up except for the paralysis of the right forearm. He died eleven days after operation. In the other patients, no symptoms were noted, not even a change in the pulse rate. We have performed this operation a number of times without any mortality or morbidity but in these patients, the lesions were not situated in the tongue or floor of the mouth so they cannot be included in this series. Curiously enough, our entire mortality and morbidity falls among the tongue and floor of the mouth cases which gives us a higher percentage in this particular series, whereas, as a matter of fact, the mortality and morbidity percentage is very low when we consider our entire number of unilateral or bilateral external carotid ligations.

Before leaving this subject, we would like to call your attention to one patient who died of the effects of hæmorrhage of the mouth although the external carotids had been ligated two and one-half months previously. This proves conclusively that the circulation reestablishes itself and the anemia is of short duration. Dawbarn says in from seven to ten days.

Other operative procedures consisted in tracheotomies in three cases, sequestrectomy from the inferior maxillæ in two cases, a very low rate considering the intensive radiation that some of these patients received, incision of the neck and implantation of bare tubes in eight cases and a total block dissection of the right neck and subtotal dissection of the left neck and amputation of the anterior part of the tongue in one case.

We are disregarding the great number of cases in which gold tubes or bare tubes in the earlier years were implanted in the lesion although an anæsthetic was often administered.

Method of Treatment—In our service at the Philadelphia General Hospital, we have had excellent opportunities to see the results of other clinics and we have come to the conclusion that no one method is the ideal way to treat cancer of the tongue and floor of the mouth. The good results have of course not come to us but the bad results have had every form of treatment possible before coming to us. Some have had surgery alone, local excision and removal of the glands of the neck. Others have had electrothermic coagulation of their lesions and some have had X-ray or radium treatment of their necks while others have not. Still another class has been treated with radium alone, although this has usually been inadequate from the standpoint of sufficient dosage.

We feel that the treatment of cancer of the tongue and floor of the mouth must be modified to the type of patient, and we advocate in those cases that are good risks and whose disease has not spread so that they are in the hopeless class radium packs to the neck, gold tube implantation into the lesion in sufficient dosage to either entirely destroy the lesion or to cause a sharp radium reaction. At the end of ten to fourteen days electrocoagulation of the lesion with possibly a preceding bilateral ligation of the external carotid,

depending upon the extent of the lesion. The neck radiation at a distance of 6 cm. is continued on both sides until an arythema dose of 10-15000 cure hours has been given. We like to give this in five divided doses at day intervals. Six weeks rest is then indicated and the patient is observed and further treatment carried out if indicated.

We have discontinued all block dissections of the neck and radical resections, as we feel that more can be accomplished with the radiation and are faced with a 10 to 20 per cent mortality in this particular type of cancer we see in the Philadelphia General Hospital when we attempt any radical surgery.

In patients who are a poor surgical risk and yet have an early or moderately advanced cancer, we carry out the treatment advocated above except that we do not always coagulate the lesions. Sometimes in these patients after the gold tubes have been inserted, the lesions have so regressed or have entirely disappeared so that coagulation is not indicated. Such has been the case in the three patients we are showing to-night.

In advanced cases, we either do not treat them at all, or else we treat their metastatic nodes vigorously and implant gold tubes into them and into the primary lesion. We regret to say that we have been unable to cure patients with metastatic nodes to the neck by irradiation. We have caused them to shrink down and have held them in check for a time, but sooner or later, these patients died of their cancer.

We have only been using gold tubes since the fall of 1926 and our results have been better since their use.

Arrested Cases—In this series there are nine patients in whom the cancer has been arrested, and who show no evidence of their disease at present. Four patients are alive over four years. One patient died after four years. He had a very thorough autopsy. He died of a retropharyngeal abscess. No cancer could be found. Two patients are alive over four years and the remaining patients—one, two years and four months and the other one year and eight months. Some of these patients have been asked to come here to-night for demonstration.

We now propose to show a few lantern slides of curves of the radiation treatment administered to some of these patients. We are indebted to Dr. Weatherwax of the Philadelphia General Hospital for these drawings. The slides are divided into two groups, the first group had a fatal termination despite the fact that they were thoroughly irradiated and the second group now free from all evidence of cancer. These curves represent fairly well the degree and type of radiation that is given at the Philadelphia General Hospital.

CONCLUSIONS

No reports of cures unless confirmed by pathological examination should receive serious consideration.

Gold tubes have supplanted any other single method of treatment.

CANCER OF TONGUE AND FLOOR OF MOUTH

of cancer of the floor of the mouth and should be combined with regional irradiation

Electrocoagulation of the lesion is desirable where conditions permit

Ligation or excision of the external carotids is essential before any radical intraoral surgery

The relief of pain is an important problem in treating cancer of the tongue and floor of the mouth

These results do not compare with those of our private patients where we receive cases in better general condition and where the disease has not made such progress

DEEP PULSION DIVERTICULA OF ŒSOPHAGUS

By MORRIS K SMITH, M D

OF NEW YORK, N Y

A TWENTY-SIX-YEAR-OLD matron entered St Luke's Hospital on account of difficulty in swallowing. The symptoms began about one year before, with a sense of discomfort on eating, beneath the lower end of the sternum, to relieve which she induced vomiting. During the intervening period there had been few days in which food had not been brought up either voluntarily to relieve distress or involuntarily. She could not get solid food down. On some days liquids would go well, on others even water was returned. She had lost eighty pounds.

She was a thin young woman not acutely ill. Neither at the first examination nor later did she seem at all neurotic. Except for the poor condition of her teeth, there was nothing of note on physical examination. Fluoroscopic and radiographic examination by Doctor Mackie revealed cardiospasm, with a diverticulum of the lower œsophagus extending forward and to the left. The size of the diverticulum is estimated at 2.5 by 2 cm. The œsophagus was much dilated. Following the passage of œsophageal bougies over a previously swallowed thread, the cardia was dilated by Dr Nathan W Green. The patient was greatly improved by the treatment, could eat again and promptly gained thirty pounds. She however, failed to report regularly for the passing of the bougies and continues to have retro-sternal discomfort at times.

The finding of the diverticulum in this patient raised the question as to its significance—whether it was a casual factor in the cardiospasm, whether in itself responsible for symptoms, and in general the problem of the importance of such diverticula. To answer these questions a review of the literature was made.

Diverticula of the œsophagus are divided generally for purposes of description into two varieties, the traction and pulsion types. The traction diverticula are due to the retraction of inflammatory tissues, usually lymph-nodes, which have become adherent to the wall of the gullet. They are found on the anterior wall, are tent shaped and rarely attain a depth of as much as a centimetre. The greater number occur at about the level of the bifurcation of the trachea where lymph-glands are numerous. They do not cause symptoms and their chief clinical significance is the possibility of perforation with ensuing fatal mediastinitis, which has been known to occur.

Pulsion diverticula, so called because they are thought to be due to pressure from within, can occur at any level of the œsophagus. Of these the pharyngo-œsophageal variety form the greater number. They arise

DEEP PULSION DIVERTICULA OF ŒSOPHAGUS

from the posterior wall at the junction of the pharynx and œsophagus, cause increasing dysphagia and are amenable to surgical treatment. The condition is a well understood clinical entity and does not fall within the scope of this paper.

Pulsion diverticula below the pharyngo-œsophageal level are unusual findings whose significance has not been clarified. The majority reported have been of the lower third of the gullet, and in this situation they are often designated as epiphrenal.

A combination of the two varieties, known as traction-pulsion diverticulum, is also described. It is supposed to begin as a traction and then take on the characteristics of a pulsion diverticulum. It is probable that a few of the cases referred to in this article fall in this class.

In a review of the literature one comes across a small group of cases, reported before X-ray examination was in use or perfected, in which diagnoses of epiphrenal pulsion diverticula of large size, 100 to 500 c.c. content, were made (Kelling¹⁶, Mintz¹⁸, Jung¹⁵). These patients suffered from dysphagia and vomiting. The diagnosis rested on tube tests more or less complicated. At least one such case has been eventually proved to be cardio-spasm with dilatation of the œsophagus (Sprink²²).

Because similar cases have not been reported of late years since modern X-ray technique has been available and because no such large sacs have been demonstrated at autopsy as far as I have found, it has seemed best not to include them.

Post-mortem reports are few and for the most part incidental findings. Reichman²⁰ stated that Przewoski searched the gullet carefully at autopsies over a period of five years and found seven pulsion diverticula of the middle and lower third, the size of a hazlenut. Brosch¹¹ reported, from autopsy material, four deep œsophageal diverticula, two at the level of the bifurcation of the trachea and two epiphrenal. All were walnut-sized. He described them as herniations through the muscular tissue of the gullet, containing only a few muscular fibres in the wall. They were incidental findings. Kraus¹⁷ reported an autopsy specimen of a dilated œsophagus on the left forward side of which was a diverticulum the size of an apple with an opening 6 by 3.5 cm. It had fibrous, thickened walls lined with mucous membrane and separated the muscle of the gullet in its development. Carman¹² refers to other reported specimens, one (Oekonumides) 5½ cm deep and 8½ cm above the cardia and one (Olivetti) the size of a hen's egg just above the diaphragm.

I have been able to find autopsy reports on three cases which were recognized during life. Two of these (Stierling,⁷ Kaufman and Kierbock⁶) were in patients with cardio-spasm. In both instances the sac was 5 cm in diameter, one a hand's breadth, the other an inch, over the diaphragm. The symptoms were those of cardio-spasm. The diverticulum in the third case (Bensaud, Gregoire et Guenau¹⁰) was the size of a turkey's egg, epiphrenal, coming from the left anterior part of the œsophageal wall. It was made up

of epithelium and fibrous tissue. The patient, a man of fifty-six, had complained of vague abdominal symptoms. A month before death he vomited up some cherries without effort on two or three occasions. He died of pneumonia.

Whether so-called deep pulsion diverticula of the œsophagus are originally congenital, or arise in some weak spot in the wall, it seems probable

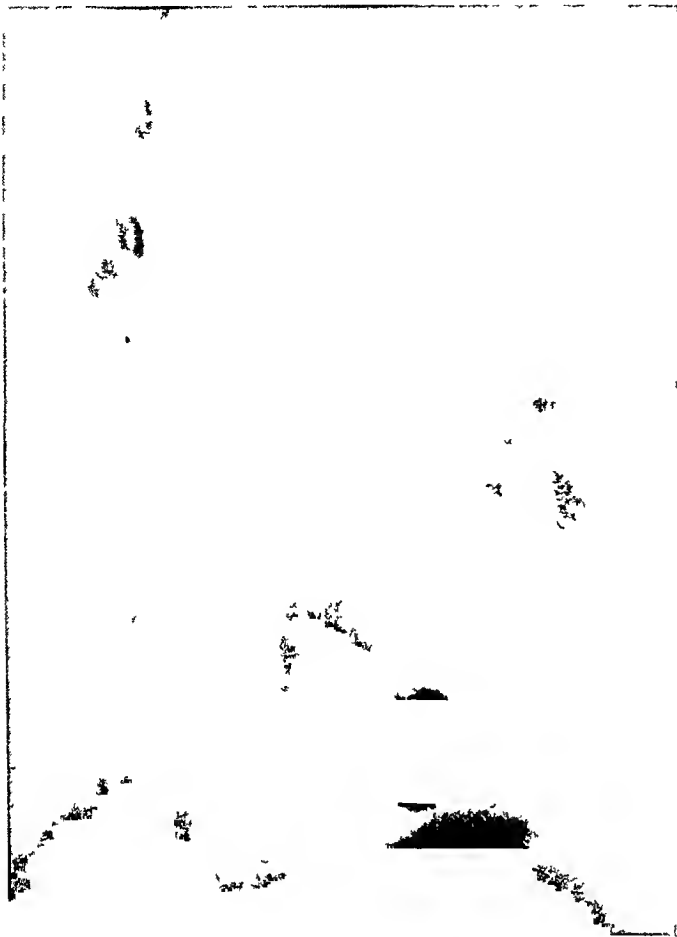


FIG 1—Cardiospasm and diverticulum of the lower end of the œsophagus before treatment

that pressure from within is a factor in their development. It is natural to reason that in cardiospasm the conditions are especially favorable for their production.

As far as I have found there are eleven clinical cases, besides my own, reported in which diverticulum other than pharyngo-œsophageal has been associated with cardiospasm. At the same time without trying to collect all other cases, I have come across more than twice as many in which cardiospasm was not reported, although the description in a few of these suggests it.

In the case reports there have been a preponderance of males over females of more than two

to one. The ages have varied from twenty-two to seventy-eight, middle and advanced life supplying the greater number. In the group associated with cardiospasm the average age is lower.

The size of these diverticula as found at autopsy has already been discussed. The X-ray has shown smaller examples. The comment of von Hacker and Lotheissen²³ in *Neue Deutsche Chirurgie* that deep-seated diverticula are for the most part not very large, the size of a pea, a hazelnut, or at most a small apple, states the case. The location of the diverticulum is in the lower third of the gullet in the great majority of cases. A moderate number are found in the mid-portion and a very few in the upper portion. Multiple diverticula are noted in a few instances. Decidedly more are found

on the right than on the left side, and more are noted as coming from the anterior part of the œsophagus than the posterior

The question as to whether deep diverticula of the œsophagus cause symptoms is the crux of this inquiry. It seems reasonable to think that the larger ones at any rate may do so, although the evidence for it is limited

Pharyngo-œsophageal diverticula cause a well-defined symptom complex of increasing severity which may lead to the death of the individual from inanition. There is a difference, however, between deep diverticula and the pharyngo-œsophageal in that the former are more or less rounded sacculations of the gullet with good-sized openings, whereas the latter become dependent pouches

Among the cases collected of deep diverticulum associated with cardiospasm the symptoms were those of cardiospasm, and were relieved by treatment of the cardiospasm in spite of the persistence of the diverticula

When it comes to the cases without cardiospasm, while the majority had no symptoms referable to the œsophagus and were accidental findings, a few presented complaints that seemed related to the diverticulum



FIG. 2.—Cardiospasm and diverticulum of the lower end of œsophagus after dilation

CHASSARD¹³ reported the case of a woman of seventy-two who had suffered from gastroptosis and hyperchlorhydria for many years. For several months eating had been accompanied by distress located behind the lower end of the sternum, and persisted for two or three hours after the meal. In consequence of this she had curtailed her food and lost weight. There was no regurgitation. X-ray showed an epiphrenal diverticulum to the left and slightly posterior, of a size between a pigeon's and a chicken's egg. It emptied in about three hours. There was no spasm seen. This patient was given an oily substance before meals. Following this treatment the symptoms diminished and she gained weight.

DESSECKER'S¹⁴ patient, a man of twenty-two, complained of pain under the breast

bone and in the shoulder after eating. There was a good sized epiphrenal diverticulum behind and to the right. He never observed any evidence of cardiospasm.

The patient of BENSARD, GREGOIRE and GUENAU¹⁰ with an epiphrenal diverticulum who came to autopsy has been described. Effortless vomiting of cherries on two or three occasions seems the only item in the history which could be connected with the œsophageal pathology. A second patient of the same authors, a man of sixty-nine, had a sensation of food stopping in the gullet. He had a diverticulum 2 cm long and four fingers' breadth above the diaphragm. The œsophagus was not dilated.

L. A. SMITH²¹ reported a patient who complained of food lodging in the lower gullet. He had angina pectoris. X-ray showed a diverticulum of medium size coming off from the right anterior wall of the middle of the œsophagus. It seemed to be adherent to the aorta.

MONTZKA¹⁰ described a man of fifty who had a peculiar foreign-body sensation in the precordial region on swallowing, and felt as if little particles stuck in the gullet. On the right anterior wall of the gullet there was a hazelnut-sized diverticulum connected by a narrow pedicle with its lumen. There was a little delay in the passage of food by the diverticulum.

These cases are not impressive as demonstrations of symptomatology due to diverticula. They suggest, however, that the condition cannot be regarded as always innocent. Among the cases collected in which cardiospasm is not mentioned, there are several with symptoms which seem to me to be probably due to cardiospasm.

The question arises when diverticulum and cardiospasm are associated as to whether the former as a source of irritation may not cause the latter.

Kaufman and Kierbock⁶ report a case in which they think that this was the sequence of events, as the patient had only had symptoms of cardiospasm for two weeks before the presence of the diverticulum was proved. On the other hand, cases of cardiospasm are relieved of their symptoms by appropriate treatment, although the diverticula remain. The question cannot be definitely answered but it seems improbable that the diverticula bear any important etiological relation to cardiospasm.

In the light of the evidence, therefore, we must conclude that deep diverticula are not of great importance and if found can be ordinarily disregarded. In the presence of cardiospasm, its treatment is sufficient. If there are symptoms in cases without cardiospasm they may be treated also by dilation. Operative removal has been attempted with fatal result.

Summary—A case of cardiospasm in which there was associated deep pulsion diverticulum of the œsophagus is reported.

A search of the literature reveals eleven similar cases, making twelve in all, and many more of deep diverticulum of the œsophagus without cardiospasm.

These diverticula vary in size from a pea to a small apple. They are most numerous in the lower end of the gullet.

Ordinarily they are accidental findings and do not cause symptoms, although a few cases are cited in which mild symptoms are reported.

It seems unlikely that deep diverticulum is of importance in the etiology of cardiospasm.

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Addendum Since this article was submitted for publication another case of deep diverticulum and cardiospasm has been reported by Fitzgibbon

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PRIMARY EXTRARENAL HYPERNEPHROMA *

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FROM THE AGNEW AND HUNTER LABORATORY OF SURGICAL PATHOLOGY OF THE UNIVERSITY OF PENNSYLVANIA

ALTHOUGH hypernephroma usually originates in the kidneys, it may develop in other organs Two years ago I presented before this Society an experimental and clinical study on hypernephroma At that time it was concluded from the embryological and pathological observations that the hypernephromata were polystructural tumors of adrenal rest origin

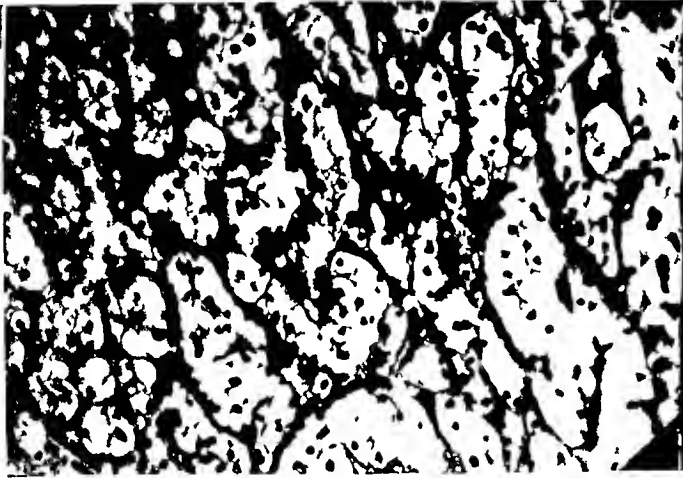


FIG 1—Adrenal like Cellular Arrangement

The present studies, the results of which are described herewith, were made upon a primary extrarenal hypernephroma with the idea of comparing the histological findings of this tumor with those of the renal hypernephroma

The paper comprises, first, an outline of the patient's history, second, a tabulation of the tissues in which adrenal tests have been found, third, a tabulation of the tissues in which primary hypernephromata have been found, and finally a discussion of the pathological findings

CASE HISTORY—The patient, a white male, aged seventy-seven years, was admitted to the University Hospital on the service of Doctor Eliason, with a chief complaint of nausea and epigastric pain The patient was in good health until eighteen months before his admission, at which time he had a sharp epigastric pain, nausea and vomiting Since then he has had intermittent attacks of postprandial abdominal distention and discomfort These sensations occurred immediately after eating and they were relieved by eructations of gas These symptoms became increasingly more prominent and weakness was progressive He had been eating lightly, not on account of anorexia, but because the food seemed to "stick on the way down" Water caused the same symptoms as food There were no severe attacks of pain since the original one There was a marked tendency to constipation with remissions but never diarrhoea He believed his abdomen had recently grown larger Hemorrhoids were present periodically for years, but during the last few months they were a constant source of discomfort His cardio-respiratory and genito-urinary history as well as his past medical, social, and family history, were negative

Physical Examination—The patient was a thin, poorly nourished, somewhat dehydrated appearing white male, seventy-seven years of age He did not appear acutely ill The physical examination was essentially negative except for the abdominal findings The abdomen was slightly distended Neither superficial tenderness nor rigidity were

* Read before the Philadelphia Academy of Surgery, May 14, 1928

present. On palpation a mass about the size of a grapefruit was felt in the upper right quadrant. The mass was smooth, tense and slightly movable. It was somewhat tender and moved with respiration. The intestinal peristalsis was of the intermittent booming type. Free fluid was demonstrable in the peritoneal cavity. The gastro-intestinal X-ray showed multiple points of stasis in the small intestine indicating slight obstruction.

The preoperative diagnosis was carcinoma of the upper abdomen of uncertain origin and chronic intestinal obstruction. An exploratory laparotomy was advised and performed by Doctor Eliason.

The abdomen was opened through a paramedian incision. The tumor felt on physical examination was easily exposed. It was found to be arising from the soft tissues in the region of the right adrenal gland. There was no evidence of intestinal obstruction. The liver contained metastatic tumors. On account of the metastasis to the liver further surgery was felt to be contraindicated. On the fourth day following operation the patient developed signs of respiratory infection. He rapidly became weaker and died from bronchopneumonia on the fifth day.

A post-mortem examination of the abdominal cavity showed the tumor which was found at operation to be definitely attached to the soft tissues just above the right adrenal glands.

The tumor measured 12 by 8 by 7 centimetres. It was well encapsulated except at its point of soft tissue attachment. It was tense and on section bulged slightly. It had a yellowish fatty appearance. There were different sized irregularly outlined cystic cavities which contained necrotic and hæmorrhagic material. The liver was slightly enlarged. This enlargement was due to three fairly well circumscribed tumors which measured about five centimetres in diameter. What was

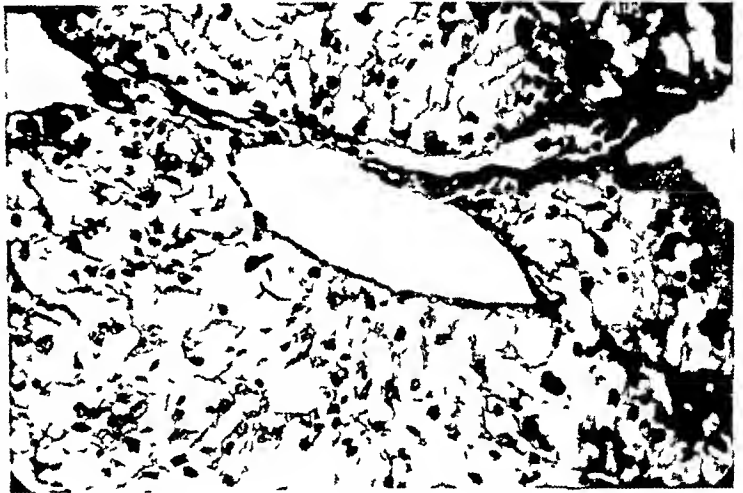


FIG 2—Endothelial Cellular Arrangement

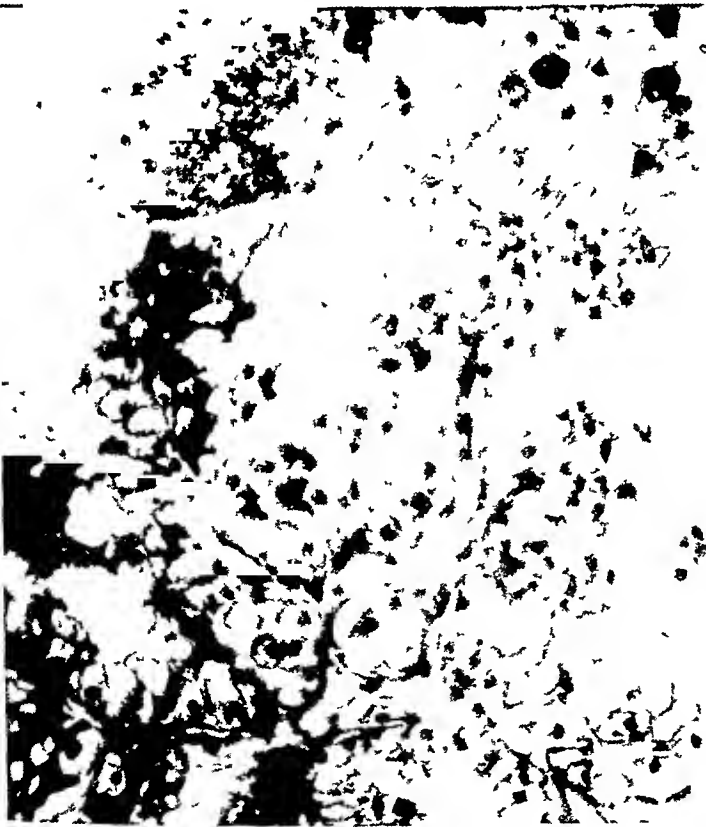


FIG 3—Papillary Arrangement

true of the gross appearance of the large tumor was true of the smaller ones in the liver. Except for the lymph-nodes in the upper abdomen there was no gross evidence of tumor in any of the other organs or tissues, the kidneys and adrenals having been very

carefully examined Many sections were cut from different areas in the tumors which will be described later

ADRENAL RESTS

Although adrenal rests are frequently found at autopsy and show a fairly wide distribution they are in entire accord with the embryological possibilities



FIG 4—Alveolar Arrangement

The anlage cells of the adrenal are so situated in their embryonic state with respect to the liver, kidney, ovary, testicle, epididymis and uterus, especially in embryos from 12 to 16 millimetres in length, that one can easily see the possibility of adrenal cell inclusions in these organs

A tabulation of the tissues and organs in which adrenal rests have been found is shown in the following table

TABLE I

1 In the male—In the rete testis and epididymis, in the paradidymis, on the spermatic cord, in the inguinal canal, and above and below the same

2 In the female—In the ovary, where they may easily be mistaken for shrunken corpora lutea, on the tubes

3 In both sexes—In the retro-peritoneal tissue below the poles of the kidneys, along the internal spermatic and ovarian veins, on the iliopsoas muscle at the brim of the pelvis, at the sacro-iliac synchondrosis, in the capsule of the kidney, and in the kidney substance, on the wall of the neighboring vessels, in the solar and renal sympathetic plexuses, between the transverse colon and the spleen, in the right lobe of the liver, in the pancreas

(Tabulated by Broman)



FIG 5—Tubular Arrangement

PRIMARY HYPERNEPHROMATA

The occurrence of primary hypernephroma is most frequent in the kidney A review of the literature gives evidence that hypernephromata may

develop primarily in any of the tissues in which adenal rests have been found. A tabulation of the tissues and organs in which primary extra renal hypernephromata have developed is shown below.

TABLE II

Liver	Adami and McCrae, Rolleston, Schmorl, Vecchi and Noyes
Falciform ligament	Starr
Adrenal	French, Linser, Orth, Dobbertin, Tilesius, Cooke, Beverant and Ravikild, Colecott Fox
Ovary	Given, Pcham, Scudder, Glynn
Broad ligament	Weiss, L. Pick, Glynn
Spermatic cord	Chuvassu, Debernardi

Microscopical Studies—Many sections were made from practically every area of the large tumor. The predominating cells, while presenting slight variation in size and shape, were of the large polygonal type consisting of a large nucleus surrounded by a clear vacuolated cytoplasm. The nuclei in most cells stained deeply. Mitotic figures were frequently seen. Although the predominating cells showed some difference in size they all appeared to be of one type, with the greatest diversity of arrangements.

The cellular arrangements noted in this tumor were 1 Adrenal 2 Endothelial 3 Papillary 4 Alveolar 5 Tubular.

The details of the cellular arrangements found were as follows:

1 Adrenal-like cellular arrangement (Fig 1) In this section there were areas in which the cells were divided into small groups by a very fine fibrous stroma. In general the areas appeared as the zona fascicularis of the adrenal gland. It differed from the latter, however, in that the cells were somewhat larger and appeared more embryonal. The type of cellular arrangement found in these sections was probably due to cutting just above or just below the supporting capillary stroma.

2 Endothelial cellular arrangement (Fig 2) In the endothelial form we have a cross section of a capillary which was identified by blood and endothelial cells. Extending out from this vessel were several layers of the large polygonal cells arranged in a radiating fashion. The fibrous stroma in this form was very scant, so scant that the cells appeared almost to be growing from the endothelial cells of the capillaries. There was apparently very little difference in the size of the cells which were nearest the vessels and those which were most distant. It was felt that this type was due to a cross section of the cells and supporting capillary stroma.

3 Papillary arrangement (Fig 3) The papillary form, like the others, was the result of capillary development and the cellular relation. Sections cut in areas in which there was free and close branching of the capillaries always showed papillary form.

4 Alveolar arrangement (Fig 4) In this type the cells were so arranged with relation to the capillaries that the tissues appeared alveolar. This appearance was due to the cross section of tumor cells surrounded by a capillary loop. In places where this capillary loop was incomplete the tumor cells were arranged in semi-papillary form.

5 Tubular arrangement (Fig 5) In some areas the capillary stroma was surrounded by a single layer of tumor cells. Alternate parallel single layers of cells and capillaries when cut in cross section have a tubular appearance. The areas in which the arrangement of the cells with respect to the capillary stroma was tubular were due to the parallel distribution of these structures.

In general it may be said from the microscopic studies of this tumor that the extrarenal hypernephromata are made up of large polygonal vacuolated cells resting upon a very irregularly arranged capillary stroma and when cut in different planes show multiple structural forms. The histological findings

in the extrarenal tumors are the same as the histological findings in the renal hypernephromata

CONCLUSIONS

1 Tissues other than the kidney are susceptible to cortical adrenal cellular inclusions, especially those which are developed from the mesonephros, mesonephric duct and genital ridge

2 Primary hypernephromata may develop in any of the tissues or organs in which adrenal rests are found

3 The predominating cells of the hypernephromata are similar to those found in the normal adrenal cortex

4 The multistructural formations of the cells in the hypernephromata are due to the plane in which the irregularly arranged capillary stroma is cut

REFERENCE

Bothe ANNALS OF SURGERY, January, 1925, vol 1XXXI, pp 57-88

SPINDLE-CELLED SARCOMA OF THE KIDNEY IN ADULTS

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AND

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THIS report is presented because of the great rarity with which spindle-celled sarcoma is encountered among kidney tumors in the adult. Spindle-celled tumors of the kidney are among the most frequently encountered tumors in children, but their incidence in adults is rare, indeed.

O. Lubarsch has emphasized this fact, basing his opinion on extensive statistics, resulting from the records of 97,498 autopsies, in which there were twenty sarcomas of the kidney, and of these only four classified as spindle-celled tumors in adults. On the other hand, 201 carcinomas were found.

The number of sarcomas recorded in the foregoing autopsies is lower than the number in the report from the Pathological Institute of the University of Berlin for the years 1898 to 1922, when thirteen sarcomas were found in 30,820 autopsies.

CASE—E. Y. B., male white, aged fifty-five, was admitted to the Presbyterian Hospital of Chicago, August 24, 1925. He complained of pain and swelling of the left testicle, pain in left side and left lower quadrant of the abdomen, all of which began six weeks ago. He also complained of hemorrhoids. The epigastric distress which occurred immediately after meals, was frequently relieved by vomiting. Loss of twenty pounds in weight in two months, slight frequency in urination, nocturia twice a night for several weeks, fever and perspiration once or twice a week for past five weeks.

Onset and Course—He stated that he began to feel under par and to lose weight about two months ago. Soon afterwards he experienced aching pains of a mild, dragging character in the left side of the abdomen, especially after walking all day. At the time of his admission to the hospital the pains had been present daily for six weeks. More annoying was the epigastric distress which occurred especially after meals, accompanied by a feeling of fullness that would often cause him to seek relief in induced vomiting. Belching and considerable flatus. Cathartics taken at intervals were followed by severe cramplike pains. Hemorrhoids, which had been removed twenty years ago, recurred in the past six weeks.

Swelling and Pain in Testicle—Swelling in the left testicle, associated with severe pain, which began five weeks ago and was noticed first only when walking, caused him considerable worry. The swelling and pain became more marked and were more or less constant. The pain radiated to the perineum and anus, but was greatly relieved upon lying down. He was chiefly concerned about being operated upon for what he described as a "painful varicocele," which he had noticed for several months.

Past History—Patient had always been well and in good health. Has had two attacks of scarlet fever, the last attack at the age of sixteen. Twenty-five years ago had chills and fever—no diagnosis made. Frequent colds during the winter. Twenty years ago hemorrhoidectomy was done and four months ago tonsillectomy. The latter operation was performed because of patient's so-called run-down condition.

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Physical Examination (Dr Donald P Abbott) —Eyes and nose normal There was a stub of tonsil present in left fossa, several crowned teeth with a partial plate and receding gums Definite apical abscesses on several teeth

Examination of chest, negative

Abdomen showed a hard firm mass which was palpable in the left flank, extending up to the ribs, across the midline, and down to a point just below the left anterior superior spine of the ileum The tumor moved slightly with respiration A mass of similar consistency, and probably connected with the first mass, was palpable just above the umbilicus Slight tenderness was present in the right flank, none to fist percussion posteriorly

The left inguinal ring was found to be somewhat enlarged A good-sized varicocele was present on the left side, with some swelling and tenderness of the testicle Rectal examination, negative Lymphatic System—Cervical axillary and inguinal glands, not palpable

Blood Examination—Red blood cells, 4,080,000, Leucocytes, 12,300, Hemoglobin, 78 per cent

Differential—PMN—57 SMN—22, LM—15, T—6

Blood Pressure—Systolic 132, diastolic 78 Blood Wassermann—Negative Blood Chemistry—Urea, 38, Uric Acid, 5.8, Creatinin, 1.76, Non-Protein Nitrogen, 32

Urinalysis—Spec Grav, 1.014 Albumin, 0, Sugar, 0, Blood +, Pus, +, Sediment, few leucocytes and red blood cells

Gastric Analysis (Dr Donald P Abbott) —Free HCL, 20, combined, 33

Stool Examination—Benzidine reaction showed four plus blood

Röntgen-ray Examination of Stomach—No constant filling defect Position of the stomach is well toward the right on the anteroposterior plate

Fluoroscopy of Stomach—Negative except stomach apparently displaced to the right

Cystoscopic Examination (H L K)—Bladder normal, both ureters catheterized without difficulty or obstruction

Examination of urine obtained at Cystoscopic Examination

	<i>Leucocytes</i> per cu mm	<i>Cultures</i>	<i>Urea</i>
Bladder	60	Sterile	1.6 per cent
Right kidney	10	Sterile	1.4 per cent
Left kidney	10	Sterile	1.75 per cent
Thalein Test			
		<i>Right</i>	<i>Left</i>
Appearance Time		4 minutes	18 minutes
1st 15 minutes		3.0 per cent	trace
2nd 15 minutes		3.8 per cent	trace
Total		6.8 per cent	Not readable

Examination of Urine for Tubercle Bacilli—Negative

Pyelograms—Right, normal Left, only a very small amount of the bromid solution was seen in the region of the pelvis of the kidney, which occurred in the form of a streak Practically a complete block of the kidney pelvis prevented the bromid solution from entering it

Diagnosis—From the findings a diagnosis of malignant tumor of the left kidney was made and operation advised

Operation (Ethylene Anaesthesia), (H L K), September 11, 1925—The usual oblique midline incision was made Muscles divided Examination showed the presence of a large tumor mass that was firmly adherent to the surrounding structures The mass was grayish pink in color and moderately firm The pedicle was about one inch in diameter and was hard and fibrous, with apparently little blood supply The pedicle was

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clamped with large clamps and the kidney removed. Ligatures were applied and clamps removed. Large tumor masses were seen both above and below the area from which the kidney was removed. They were not removed because of their extent and because of their proximity to the large vessels (involvement of lymph glands).

Post-Operative Course—Good immediate recovery. The stitches were removed on the ninth day. The wound was completely closed and the patient went home on the eighteenth day. Intermittent temperature up to 102° , rapidly falling to normal and staying down after the fifth day.

Subsequent Course—The patient gained in strength and his general health improved for several months, then gradually he lost what he had gained. There was an extensive local recurrence of a very large tumor mass. He died in March, 1927. No autopsy obtained.

Pathological Report—The tumor is large, irregularly oval, the size of a grape fruit, weighing 750 grams and measuring $13 \times 9\frac{1}{2} \times 7$ centimetres. It is composed largely of a pale gray, soft, rather elastic tissue through which pass strands of a denser white structure dividing the tumor into lobules. There are no areas of degeneration, but there is a rather extensive area of hæmorrhagic infiltration passing across the centre of the tumor, which shows microscopically to be composed of thin-walled blood spaces. Near the kidney pelvis, the layers of fibrous tissue are pressed together, completely obliterating the pelvic space. Only a small amount of the kidney tissue remained.

Microscopic—Several different types of tissue are present. There are areas that present the typical picture of a spindle-celled sarcoma with

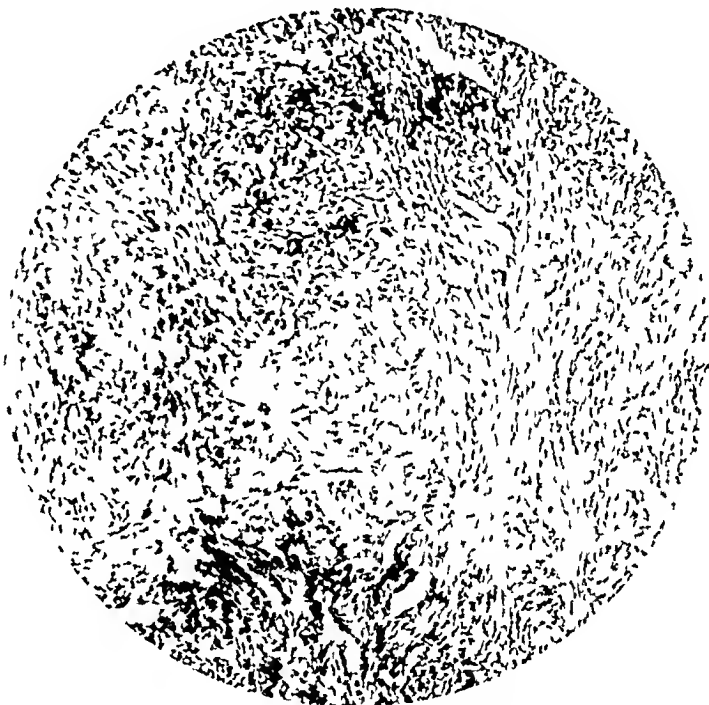


FIG. 1.—A large proportion of the tumor is made up of this type of tissue with intersecting bundles of spindle cells and large vascular spaces.

closely packed spindle cells, running at various angles, and in the high power field numerous mitotic figures, in places six or eight to the field (Fig. 1).

Another picture that is seen is that of a large thin-walled blood space, with a thin stroma and small spindle cells. There are also areas composed of small spindle cells, thinly distributed in a pale staining stroma.

Pathological Diagnosis—*Spindle-Cellled Sarcoma*—The microscopic character, the size of the tumor, and the clinical course demonstrate malignancy.

The classification of kidney tumors has been very greatly modified, since the introduction and acceptance of Grawitz's theories as to the origin of certain neoplasms of the kidney which now go by the name of "Hypernephroma." Grawitz's work was published in 1883, but Garceau in investigating the subject of renal tumors, twenty-six years later, found that considerable confusion still existed with regard to classification, and his statement made at that time is to some extent still true today. "Carcinoma,

sarcoma, adenoma, and adenocarcinoma have been persistently and frequently confounded with hypernephroma in the published clinical and pathological reports of cases so as to make nearly all of the material relating to these tumors of little value"

Noticeable has been the diminution in the number of reported cases of sarcoma of the kidney in the adult Albaran and Imbert reported twenty-one per cent of 380 cases prior to 1901 as sarcoma Since that time, the incidence of sarcoma has decreased, and that of hypernephroma has increased

The tumor most difficult to distinguish from spindle-celled sarcoma of the kidney is the retroperitoneal sarcoma so frequently found behind the kidney or in the position of the kidney, which may easily be mistaken for a kidney

tumor if the pathological data are not complete Bland Sutton calls attention to this and states, "As far as my experience goes, this is a far more frequent site for them than for those which we term renal sarcoma" The case reported here is an excellent example of this difficulty, as the tumor has almost completely replaced the kidney

The point of origin of these tumors is difficult to establish In six of the collected cases, no point of origin was stated in the reports Two were defi-

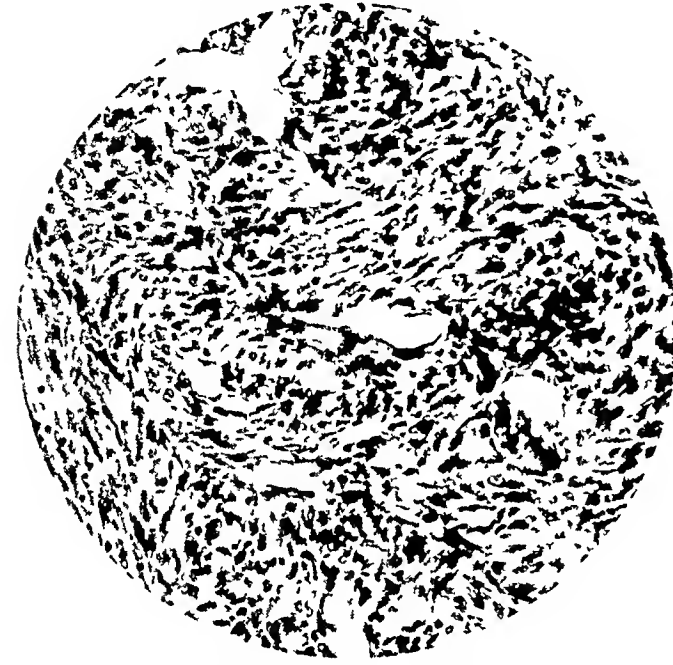


FIG 2—Higher magnification showing several mitotic figures

nately from the kidney pelvis, and two from the capsule Boyd states "True sarcomas, round or spindle-celled, probably always arise in the kidney capsule from which they invade the kidney" Bland Sutton is somewhat of the same opinion, and calls attention to the fact that sarcomata of viscera having similar coverings—spleen, thyroid, prostate, etc, while uncommon, are often closely connected with the connective tissue investing the organ

Symptomatology—Age incidence All except one of these case reports are of patients of thirty-seven years or over The youngest was twenty-four and the oldest sixty-eight years of age

Hematuria was present in only three, absent in five and probably absent in the three cases in which it was not mentioned Red blood cells were reported in the urine of only two of the cases It seems most reasonable to expect hematuria to be frequently absent in tumors developing from the capsule, but generally present in those of stroma and epithelial origin

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Varicocele and hemorrhoids were the most troublesome symptoms in the case reported here—developing rapidly in six weeks' time Braasch, in 1913, found varicocele in ten out of thirty cases, and hemorrhoids of recent origin in five cases Varices of the bladder were present in four out of fifty cases Williams reported thirty-six cases of kidney tumors in adult males—with three varicoceles This series consisted largely of hypernephromas

Guyon, in 1881, first called attention to the "symptomatic" varicocele as being of special significance and most often caused by kidney tumors, "independent of involvement of the paravertebral lymphatics"

Loss of weight was present in six, absent in one, and not reported in four of the reported cases

The tumor was felt by the patient before admission in six cases, not felt in one and not reported in four Right kidney involved in six cases and the left in six

Cystoscopy was performed in only two cases, but in the rest, the diagnosis did not appear to be the question One case was diagnosed ovarian cyst, however, before operation

Inflation of the colon for diagnostic purposes was practiced in only one of these cases

The pre-operative diagnosis of sarcoma of the kidney as differentiated from the other types of kidney tumor, is practically impossible A diagnosis of tumor is simple enough but there is no symptom or sign that justifies making a diagnosis of sarcoma, particularly if we bear in mind the great rarity of these tumors in the adult

SPINDLE-CELLED SARCOMA

Symptoms

1 Cassell, female, aged forty-nine, hematuria, +, pain, L, loss of weight, +, œdema or varicocele, abd, constipation, +, tumor felt by patient, +, palpable tumor, L, urine, abd pus, operation, L nephrectomy, result, not stated

2 Chifoliau et Masson, female, aged forty-six, hematuria, NS, tumor felt by patient, +, palpable tumor, +, operation nephrectomy, origin of tumor, vascular, result, not stated

3 Eliot, male, aged fifty-five, hematuria, +, pain, L, palpable tumor, L, urine, blood, cystoscopy, both ureters catheterized, no urine from left, discharge of blood from left, right normal, operation L nephrectomy, origin of tumor, kidney pelvis, result, good recovery

4 Heuston, female, aged twenty-four, hematuria, +, pain, +, tumor felt by patient, +, palpable tumor, R, operation R nephrectomy, origin of tumor, pelvis involved many cysts of parenchyma, result, uneventful recovery

5 Kretschmer and Randolph, male, aged fifty-five, hematuria, O, pain, L, gastric disturbance, +, loss of weight, +, œdema or varicocele, varicocele, hemorrhoids, +, palpable tumor, L, urine, pus blood, cystoscopy, bladder normal—both ureters catheterized, pyelogram, left showed conformity compatible with tumor, operation, L nephrectomy, result, died one year seven months following operation

6 Picque, female, aged forty-five, hematuria, O, pain, R, palpable tumor, L, urine, alb, operation, L nephrectomy, result, not stated

7 Rabe et Morel, male, aged fifty-four, hematuria, O, pain, L, œdema or varicocele, œdema legs, palpable tumor, L, operation, died nine days after admission to hospital

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and before operation, origin of tumor, autopsy almost complete destruction of kidney, many cysts containing hemorrhagic fluid, result, died nine days after admission

8 Ralphs, female, aged thirty-nine, hematuria, O, pain, R, tumor felt by patient, + palpable tumor, R, operation, R nephrectomy, origin of tumor, pelvis (?), result, died few minutes following operation

9 Reisterer, female, aged sixty-eight, hematuria, NS, loss of weight, +, œdema or varicocele œdema ankles, eyelids, abd, tumor felt by patient, + palpable tumor, R, operation, R nephrectomy, result, died eleven days following operation

10 Reisterer, female, age, NS, hematuria, NS, pain, R and L and abd, loss of weight, +, constipation, +, palpable tumor, mass diag, ovarian tumor, operation, R nephrectomy, origin of tumor, "found in the retroperitoneal position in right kidney region" from kidney capsule, result, not stated

11 Schwartz, female, aged fifty-four, hematuria, O, pain, +, œdema or varicocele, abd, varices left leg, constipation, +, tumor felt by patient, +, palpable tumor, R, operation, R nephrectomy, origin of tumor, fibrous capsule right kidney, result, complete recovery

CONCLUSIONS

- 1 A case of spindle-celled sarcoma in an adult is reported
- 2 The statement, that this is a relatively rare type of tumor of the kidney, seems justified
- 3 A pre-operative diagnosis of tumor, probably hypernephroma was made in this case
- 4 A clinical or pre-operative diagnosis of sarcoma is practically impossible

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CONGENITAL ABSENCE OF ONE KIDNEY

UNILATERAL RENAL AGENESIS

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CONGENITAL absence of one kidney is most often an autopsy finding. When the lesion is recognized during life, it is usually only after disease and frequently extensive destruction of the solitary kidney has been proven. The condition, therefore, is of great importance and interest to the surgeon performing operations on the urinary tract. We are herewith presenting a clinico-pathological study of nine cases of complete unilateral agenesis of the kidney as found in 13,000 autopsies at Bellevue Hospital and one case presumably of this character observed clinically. While renal aplasia or incomplete development may be equally important clinically and is four times more frequently observed, we are not concerned here with this anomaly.

Fortunately, unilateral renal agenesis is not common. In this series the incidence is one in every 1,444 cases. Anders¹ in 1910 found the ratio to be one to 1,817 in 92,690 autopsies. Adding to this number our 13,000 autopsies and others reported since 1910, totalling 122,320 autopsies, we find an incidence of one in 1,610 cases.

EMBRYOLOGY

The failure of the Wolffian duct to give off a renal bud after the duct has reached the cloaca is the embryological explanation of unilateral renal agenesis. In some cases a rudimentary ureter represented by a fine fibrous thread or a partially patent tube is found leaving the bladder at the normal ureter exitus, but this aplastic ureter usually disappears some distance below the kidney region. Non-development of nephrogenic tissue is the probable explanation of such a finding. There are often associated genital anomalies. This is particularly true in females, and results from defective Mullerian duct development. In one of our cases there was marked aplasia of the female generative organs isolateral with the renal absence, in another, there was isolateral aplasia of the male seminal tract.

CLINICAL CONSIDERATIONS

Unfortunately there are no pathognomonic signs or symptoms of unilateral kidney. Urinary frequency, pyuria, and occasionally anuria have prompted most urological examinations revealing congenitally absent kidney. In none of our autopsy series was the condition suspected during life. Physical examination gave no clue suggesting unilateral kidney and in but

TABLE I

Case	Age	Sex	Side	Adrenal	Renal vessels	Ureter	Bladder	Genitalia	Principal disease	Remaining kidney
1 M S	1 mo	F	L	Absent	Absent	Absent	No dimple	Unicorn uterus, no left Fallopian tube, atrophic ovary	Marasmus	Normal
2 R T	5 da	F	L	Not recorded	Absent	Absent	No orifice	Unicorn uterus, suprapelvic left ovary Perineal maldevelopment	Pneumonia	Normal
3 A C	36 yr	F	R	Absent	Absent	Fibrous thread to retroperitoneal fat	No orifice	Grossly normal	Carcinoma of breast	Ureter and kidney dilated without obstruction Kidney large and flabby
4 S Y	36 yr	M	R	Absent	Absent	Absent	No dimple	Rt testicle atrophic retroperitoneal Rt seminal vesicle and vas deferens atrophic Verumontanum opens on urethral floor No elevation	Pneumonia	Normal
5 K M	35 yr	M	L	Absent	Absent	Absent	No orifice	Grossly normal	Uremia	Scarred kidney of nephritis
6 J F	40 yr	M	L	Not recorded	Absent	Absent	No orifice	Grossly normal	Pulmonary tuberculosis	Hyperplastic
7 C J	69 yr	M	L	Not recorded	Absent	Absent	Dimple	Grossly normal	Pneumonia	Hyperplastic
8 M M	54 yr	F	R	Not recorded	Absent	Absent	Dimple	Grossly normal	Endocarditis	Multiple infarction Left kidney much enlarged
9 S M	1 yr	M	L	Not recorded	Absent	Absent	Dimple	Grossly normal	Uremia	Acute focal suppurative nephritis
				Right kidney near midline The ureter showing a dense stricture of 1 cm above bladder						

CONGENITAL ABSENCE OF ONE KIDNEY

three instances—those patients dying of renal failure—did urinalysis indicate nephropathy. In a few cases reported by others loin pain on the affected side has been present.

In some of this latter group the diagnosis was made only at operation. The surgical import of this condition has been forcibly stressed by Ransahoff,² who in 1912 collected eleven cases in which, unknowingly, the only kidney had been removed or otherwise surgically incapacitated (nephrotomy, etc.). All died promptly of uremia.

Careful cystoscopic examination and the liberal use of indigo-carmin intravenously are perhaps of greatest diagnostic aid. When the dye is employed, the patent ureter should of course be plugged with a large catheter. Ectopic or extravescical ureteral openings, particularly into the urethra or vagina, must not be overlooked. Plain roentgenograms do not always assist, but may do so in a negative way when they indicate the presence of a probable kidney shadow on the suspected side. It must be borne in mind too that occasionally crossed dystopia with renal fusion occurs, as observed in an autopsy at Bellevue some time ago. The fused kidney was found on the right side but showed two ureters emptying into the bladder in normal positions. In such a case plain roentgenogram would suggest an absent left kidney, but pyelography would indicate the character of the anomaly. Occluded renal tuberculosis has been confused with renal agenesis and aplasia. Inability to find a ureteral orifice or to pass a ureteral catheter is in itself, of course, inconclusive evidence of renal absence.

CASE 10—C. C., aged six years, admitted because of freely movable mass in right lower quadrant without pain. Urine showed many pus cells. Total phenolsulphone-phthalein output 35 per cent in two hours. Plain roentgenogram showed no evidence of left kidney, right kidney shadow lower than normal but of normal size. Cystoscopy reveals no left ureter orifice, catheter passed up right ureter easily to kidney pelvis, obtaining a hydronephrotic drip. Indigo-carmin intravenously appeared in deep concentration from the right side in six minutes and with this catheter firmly plugging the orifice, no blue was seen to enter the bladder, urethra, vagina, nor did any appear in the rectum. Pyelogram revealed a dilated ureter and right kidney, moderate ectopy and no evidence of left renal shadow. The indigo-carmin test was repeated twice subsequently and never was evidence of another ureteral opening obtained. While renal exploration of the left side was not performed and this case therefore lacks the final proof of the others here reported, we feel confident that we are dealing with the same type of case, certainly of marked aplasia if not actually agenesis of the kidney.

Age—This is a factor of comparatively little importance. Just as many nephrectomized patients live the normal span of life, so may those congenitally allotted but one kidney enjoy a fair life expectancy. However, we found that a third of the autopsy cases of this series died with renal failure. Our youngest was five days of age, our oldest patient was sixty years of age.

Sex—We do not know why the incidence should be greater in the male. Statistical study reveals this to be apparent, but it has been suggested that more autopsies are performed on males. This seems to be the likely explanation as there is no embryological interpretation. Five of our cases were males, five were females.

CONGENITAL ABSENCE OF ONE KIDNEY

Side Involved—Here again an inexplicable predisposition apparently exists. The left side is involved considerably more often than the right. In our series agenesis occurred on the left side six times, on the right side three times and once the solitary kidney (not a fusion) was found in the midline somewhat to the right side. Approximately this ratio has been noted by others.

Adrenal—This organ was absent on the involved side four times, it was not described in five cases. It was recorded as normal on the side of the solitary kidney in all cases. Absence of the adrenal probably results from isolateral vascular agenesis.

Renal Vessels—Renal vessels were not found in seven cases and in two instances their presence was not recorded. If evidence of renal vessels is found, one should examine particularly carefully for indications of a degenerated kidney—a cystic or fatty mass in the site of the normal kidney. In a series of thirty-nine cases of renal aplasia which we are reporting elsewhere, a few fall within this degenerative type and unquestionably would be overlooked did not the atrophic vascular supply give the clue. Clinically, of course, this point is of no moment.

Ureteral Agenesis—In but one of our cases was there evidence of ureteral budding. A fibrous thread left the bladder at the normal exit but was lost in the lumbar retroperitoneal fat. There was no lumen and a dimple only was present at the normal ureteral orifice. A normal-sized ureter, particularly if patent, should cause one to seek zealously for the remains of a degenerated kidney. Ball³ reported a case in which such a ureter became a huge cystic mass, bringing the patient to operation.

Bladder—In none of our cases was a ureteral opening present on the affected side, a dimpling was seen in four cases, however. The appearance of the trigone was not recorded. Some observers have noted absence or hypoplasia of the trigone with absence of the ureteral orifice.

Genitalia and Reproductive Organs—Aplasia or agenesis of these structures is occasionally associated with renal agenesis. A unicorn uterus with most rudimentary ovary and Fallopian tube was found in two instances. In another, the testicle on the involved right side was retroperitoneal and atrophic. The right seminal vesicle and vas deferens were likewise atrophic. The character of the epididymis was not recorded. The verumontanum did not project as normally, but was represented by a deep depression on the floor of the urethra. Others have noted the complete absence on the same side of the prostate, epididymis, vas deferens, seminal vesicle and ejaculatory duct. In females, the uterus has been found absent in some cases and vaginal anomalies have been present. In seven of our nine autopsy cases the genitalia were normal.

The Solitary Kidney—Perhaps the greatest clinical interest focuses on solitary kidney. The burden thrown on this organ is frequently overwhelming and at autopsy in three of our cases a destroyed kidney was found. Once there was generalized infarction, once acute suppurative focal nephritis,

KIDNEY RESECTION

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RECENT literature on renal surgery indicates that surgeons are recognizing the value of conservative surgical procedures on the kidney

In the early days of renal surgery nephrectomy was fraught with much uncertainty and high mortality, and only rarely done. When it was found that incisions might freely be made in the kidney substance and that they healed readily, resection or partial nephrectomy was attempted. This operation showed a much lower mortality than nephrectomy and consequently, for a short period of time, it was considered a more desirable surgical procedure. The fragment of kidney not removed usually healed promptly and preserved a portion of functioning tissue.

Historical—As early as 1886, only a few years after nephrectomy had become an established operation, Czerny¹ removed a portion of a kidney following trauma. This was really an emergency procedure, but the following year he did the first deliberate resection of a kidney, removing the lower pole, which contained angio-sarcoma, in 1889 he carried out three further resections. At about the same time Kummell² also resected a segment of a kidney for stone and abscess.

Von Schmieden,³ in 1901, collected reports of thirty-four cases of resection in 2,100 kidney operations. In 1,118 total nephrectomies there was a mortality of 27 per cent. Only four (11.8 per cent) of the patients in the thirty-four partial nephrectomy cases died. Moynihan,⁴ in 1902, reported two cases of resection of the kidney, one for cyst and the other a case of excision of half a kidney for myxosarcoma. In both his cases a wedge of kidney substance was removed and the wound was closed by interrupted catgut sutures. Henry Morris⁵ reported a case in which one kidney was removed for tuberculosis, later one-third of the remaining kidney was excised. The patient was well five years after the latter operation. A similar case was reported by Papin.⁶

Berti⁷ collected reports of 112 cases of resection of the kidney from the literature up to 1921. Eighty-six recovered and eleven died. The outcome was unknown in fourteen. A total nephrectomy was necessary later in seven cases and a fistula persisted in five. The total 112 cases included five of cancer, with two cures, fifteen of tuberculosis, with seven cures, fifteen of simple hydronephrosis, with fourteen cures, and eighteen of horse-shoe kidney, with twelve cures.

How Much Kidney Substance Is Necessary to Support Life?—The work of Tuffier⁸ thirty years ago, and that of Bobroff⁹ later, demonstrated that life could be supported on a very small portion of a normal kidney. Tuffier,

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RECENT literature on renal surgery indicates that surgeons are recognizing the value of conservative surgical procedures on the kidney

In the early days of renal surgery nephrectomy was fraught with much uncertainty and high mortality, and only rarely done. When it was found that incisions might freely be made in the kidney substance and that they healed readily, resection or partial nephrectomy was attempted. This operation showed a much lower mortality than nephrectomy and consequently, for a short period of time, it was considered a more desirable surgical procedure. The fragment of kidney not removed usually healed promptly and preserved a portion of functioning tissue.

Historical—As early as 1886, only a few years after nephrectomy had become an established operation, Czerny¹ removed a portion of a kidney following trauma. This was really an emergency procedure, but the following year he did the first deliberate resection of a kidney, removing the lower pole, which contained angio-sarcoma, in 1889 he carried out three further resections. At about the same time Kummell² also resected a segment of a kidney for stone and abscess.

Von Schmieden,³ in 1901, collected reports of thirty-four cases of resection in 2,100 kidney operations. In 1,118 total nephrectomies there was a mortality of 27 per cent. Only four (11.8 per cent) of the patients in the thirty-four partial nephrectomy cases died. Moynihan,⁴ in 1902, reported two cases of resection of the kidney, one for cyst and the other a case of excision of half a kidney for myxosarcoma. In both his cases a wedge of kidney substance was removed and the wound was closed by interrupted catgut sutures. Henry Morris⁵ reported a case in which one kidney was removed for tuberculosis, later one-third of the remaining kidney was excised. The patient was well five years after the latter operation. A similar case was reported by Papin.⁶

Berti⁷ collected reports of 112 cases of resection of the kidney from the literature up to 1921. Eighty-six recovered and eleven died. The outcome was unknown in fourteen. A total nephrectomy was necessary later in seven cases and a fistula persisted in five. The total 112 cases included five of cancer, with two cures, fifteen of tuberculosis, with seven cures, fifteen of simple hydronephrosis, with fourteen cures, and eighteen of horse-shoe kidney, with twelve cures.

How Much Kidney Substance Is Necessary to Support Life?—The work of Tuffier⁸ thirty years ago, and that of Bobroff⁹ later, demonstrated that life could be supported on a very small portion of a normal kidney. Tuffier,